Nanna oder Über das Seelenleben der Pflanzen

About the Inner Life of Plants

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Draft English translation

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Untitled

Nanna
or
On the Soul-Life of Plants
by
Gustav Theodor Fechner

Preface

Vorwort.

I confess that I have had some misgivings about bringing forward a subject so entirely dreamy in appearance, lying as it does within the most peaceful domain of nature, at a time when the magnificent impulse and movement of the age claims the attention and interest of every man — even the most ordinarily peaceable — so predominantly, and in relation to matters of so much greater moment. Do I not ask that one should begin, amid the roaring of a wind capable of felling the most ancient and deep-rooted trunks, to hear the hitherto unheard whispering of flowers in their stillest hours — that one should learn to believe in it, to attend to it, at a time when the loudest human voice finds it difficult to make itself heard or to maintain its ground? This work, moreover, has already lain finished and idle for some considerable time.

Yet I once read that, in certain forms of deafness, soft voices are heard all the more clearly the more loudly a drum is beaten at the same time. The very shock that stupefies a wakeful ear may arouse the sleeping one. Now I am well aware that the drum of the age is not beaten in favour of the soft voices of flowers; but might it not, even so, prove of some benefit to the hearing of those voices? How long has our ear been deaf to them — or rather, how long is it since it became so deaf; and will it not now be all the more easily moved again by these long-forgotten voices of an early youth,

the more strange and novel their sound as it rings into the surrounding tumult or fades away from it? Indeed, am I too bold if I hold it possible that the unknown, gentle play which will here unfold itself may strike many like an anticipated chord from a fresh season of youth — one that must one day blossom forth in knowledge as in deed from the grave into which the old age is sinking with already audible rumbling?

To this reflection, by which I sought to encourage myself, there was added the thought that once the first impetus of a restless spirit of the age — if not wholly appeased, yet somewhat relaxed in its tension — and the protracted duration of the movement itself had here and there already awakened a need for change and for points of repose, a return to quieter interests might here and there prove welcome. Will not many even of those upon whom the stirring of the human world has pressed most heavily be glad, now and then, to seek for a brief time a resting place in another world, among beings that nestle in quiet contentment at their feet, where none presses upon him, none upon another, and which speak only so much as he himself will permit them to speak? Into such a world do I wish to lead the reader, and I will myself step before these small creatures and play their interpreter, so that, now that every people has found its representatives, this little folk too shall not go without one. Only those to whom the invitation is welcome need follow it.

Perhaps the title-word of this work may be thought far-fetched; in truth, however, it was simply found. Wishing to place a proper name before it as the briefest of designations, I wavered for some time between Flora and Hamadryas. The

former name seemed to me too botanical in character, the latter somewhat too stiffly antiquarian, and, moreover, pertaining only to the life of trees. In the end Flora stood once more upon the title-page, when I chanced upon the following passage in Uhland's Myth of Thor (pp. 147, 152), a passage that appears to me to contain so much that is graceful and charming that I cannot deny myself the pleasure of setting it down in full, the more so as it offers many points of closer connection with the contents of our work.

"Nanna, the wife of Baldr (the god of light), is the blossom, the world of flowers, whose fairest season coincides with Baldr's reign of light. In support of this speaks first the name of her father Nep (Nepr), meaning knob or bud; the daughter of the flower-bud is the blossom. In Saxo, Baldr's love for Nanna is kindled when he beholds her radiant beauty at the bath; Nanna unclothed and bathing, espied by Baldr, is the blossom opened by the light and freshly bedewed; the poetry of antiquity never conceives of the most delicate flower-radiance save as bathed in dew. With the waning of the light the richest, most fragrant life of flowers likewise draws to its close. When Baldr's corpse is borne to the funeral pyre, Nanna bursts asunder with grief; this expression is also used elsewhere for a broken heart, but it is peculiarly fitting for the flower that sheds its petals. From the dwelling of Hel (the underworld), where Nanna abides with Baldr, she sends gifts to the goddesses Frigg and Fulla — to the former a woman's veil, to the latter a golden finger-ring. Frigg is the goddess who presides over conjugal love, and therefore receives the veil, which appears elsewhere too as the badge of the house-

wife. Fulla, Frigg's handmaid and confidante, with her hair flowing freely in maiden fashion, is the fully-grown bridal virgin, and therefore the betrothal ring befits her. The veil and the golden ring which Nanna sends up as remembrances even from the dark underworld are in all likelihood nothing other than the flowers of late summer. Just as the eyes of Thiassi and the toe of Orvandil were set among the stars, and a constellation was named in Swedish Friggerock after Frigg's housewifely distaff, so too were flower- and plant-names drawn from the world of the gods: Baldr's Brow, Tyr's Helm, Thor's Hat, Sif's Hair, Frigg's Grass — to which Frigg's Veil and Fulla's Finger-Gold may now be added. The bright, varied play of the Norwegian meadow-flowers is renowned; a brief yet ardent summer brings them forth in rare abundance and variety. — Even as Thor is a friend to the other goddesses of the fair and fruitful season — Freyja, Idun, Sif — and takes an active part in their concerns, so too must the death of Nanna, the loveliest adornment of the earth under his protection, touch him nearly; and he gives expression to his defiant displeasure by hurling after her into the fire the dwarf Litr, who runs across his path. Litr (Litr), colour, the rich and vivid bloom of early summer, must descend likewise when Baldr and Nanna are turned to ashes."

Now since it is the purpose of this work to present the plants, within a nature animated throughout by divinity, as once more partaking in their individual measure of that animation — and in particular to depict their intercourse with the god of light, Baldr, or, more briefly and simply, to attribute to them a soul of their own and to interpret their in-

tercourse with the light in psychological terms — and since moreover the German spirit now desires to renew itself, to become once again self-grown and to cast off the all-too-beautiful classical periwig, it seemed to me that the ancient Gallic pagan Flora must needs yield her place to the young German goddess Nanna. The former has, after all, had one foot long since in the grave of the herbaria, and before long the whole of foreign antiquity will doubtless lay itself to rest in the coffins of history. A native spirit-world — and may God grant it a divine world once more — might rise from native soil in its stead, and let Nanna walk in the van to herald the new season of blossoming.

Granting the possibility of a well-founded resolution of our task, it may perhaps seem to some that no such great expenditure of effort need have been made in arriving at it as has been made here. Indeed, I must still leave open the question whether the interest of others will be capable of following me as far as my own love of the subject has led me. In the meantime, since what was required here was the earnest grounding of a view that at present stands equally opposed by common and by scientific opinion alike, and since the subject offers a great variety of facets and points of attack, too brief a treatment would have failed to answer the purpose. One would, moreover, soon find that the question with which we are here concerned does not possess quite so isolated an interest as it might perhaps appear at first glance. Whether plants are ensouled or not alters the entire view of nature, and many other questions are decided along with this one. The whole horizon of the contemplation of nature expands

with an affirmative answer, and even the path that leads thither brings to light perspectives that do not enter into the ordinary mode of consideration.

Schleiden says in the introduction to his work on the plant (p. 2):

"I attempted to show how botany is connected in the closest manner with almost all the deepest disciplines of philosophy and natural science, and how almost every fact or larger group of facts is fitted, in botany no less than in any other branch of human activity, to stimulate the most serious and important questions and to lead man from the sensibly given toward the divined supersensible."

One will readily believe that, if the consideration of the material side of plant life may lay claim to such significance, then all the more will the consideration of its ideal side demand it. I therefore permit myself to apply those words to my own work, with only this modification: that instead of pursuing with particular fondness the points of connection — all too abundantly offering themselves — between our subject and philosophy, I shall rather endeavour to meet the, only too great, temptation to do so with the utmost possible restraint; for I am indeed persuaded that moderation in this respect will here be more deserving of gratitude. A few further words on this point will be found in the following introduction to the work.

What has contributed in part to enlarging the scope of this work was the wish to combine, along with an exposition of the grounds for our view, an account of the actual circumstances which promise to be of relevance to the resolution of

our question at all. Undoubtedly, the standpoint from which this compilation has here been attempted, should it be regarded as valid, will only serve to increase the interest which the facts bearing upon the matter already possess in their own right; but even apart from this, the small collection of them may not be unwelcome to many as material for any thoughtful contemplation of plant life in general; and with this purpose in mind, without overstepping the connection to our subject, I have provided a somewhat richer body of material than would have been strictly necessary to satisfy its requirements alone (cf. in particular the 7th, 8th, 9th, 11th, and 12th sections). Professional botanists will, of course, find here not an augmentation but merely a use of their own treasures — which, however, was all that could be intended in this place.

What, in the end, will be the outcome of this work?

If I divest myself of all poetic illusions, I think the following:

A young girl of my acquaintance does not hold the most compelling views on every matter. One takes some pains to instruct her in something more convincing through the best possible presentation of reasons. She listens to these reasons, or does not listen to them, and says at last, simply: "Even so!" — and remains of her opinion.

My arguments may be good or poor; people will very likely say likewise: "Even so!"

But even so! — Did I not harbour some hope that at least the feeling of the young girl might be won over — that feeling which, as young girls are, always runs ahead of her under-

standing — I should indeed spare myself all the trouble. But should this succeed, then all the arguments would afterwards sound admirable too. By the young girl, however, I mean the young age.

24th August, 1848.

I. Statement of the Problem

I. Stellung der Aufgabe.

But it may also be otherwise. Perhaps the divine soul works in plants, as parts and members of universal nature, only in the manner that our own soul works in any individual members of our body. None of my limbs, presumably, feels anything for itself alone; only I, the spirit of the whole, feel everything that passes within them. And understood in this way, one could likewise speak of no soul proper to the plants, if only God were to know what passes within them, and not the plants themselves.

Thus nature might well be regarded as universally and divinely ensouled, and yet the question would remain entirely undecided whether plants too are to be considered as ensouled in their own right. Yet it is always only such ensoulment of this latter kind that we have in mind when we inquire after the soul of the plant.

Naturally, the question of whether plants are ensouled must come into ever sharper relief when one abstracts from, or indeed denies, the ensoulment of nature as a whole, as is more in keeping with the ordinary mode of conception. In that case, ensouled creatures appear amidst the rest of nature as islands in a general ocean of the soullessly dead; and the question presses more urgently than before: shall we raise the plants, together with animals and men, out of this nocturnal

ocean into the light of soul, or shall we sink them with stone and bone into its depths?

One can already see from these fleeting reflections, which yet touch our subject so profoundly, that even the preliminary discussions threaten to carry us very far indeed. Discussions of the most general relations between God and nature, between body and soul, seem as though they must precede all else, in order to lay the foundation; and more precise determinations of what is to be understood by individuality, psychical unity, consciousness, and its various degrees, appear to be required from the very outset. Only then might the task seem thoroughly prepared for the assault. But who is not already wearied by such discussions, and who would in the end consider anything to have been gained by them? In truth, however much that is profound has been said in such discussions hitherto, it has served far more to deepen the obscurity surrounding their objects than to bring them into clear light.

With this consideration in mind, I would rather renounce from the outset any claim to such depth, and attempt instead to descend toward it as far as may prove possible, rather than to build upward from it. One may well pluck a flower without tearing it up by the root; and if the flower pleases, the spade will perhaps be found in due course to lift it from the depths for lasting transplantation into the proper bed of the garden.

And so, setting aside the pursuit of those reflections first struck upon, as well as all far-reaching discussions in general, what follows will be merely an attempt to arrive at an answer to the question of how far one may conceive of a psychical constitution in plants similar to that of animals and of our-

selves, by means of as direct a reference as possible to professional considerations that are in themselves little contested and readily accessible to general comprehension, without moreover seeking or being able to determine precisely how far we are to think of the animals themselves as similar to us in this respect. A field of entirely clear contemplation cannot exist where we undertake to speak of the psychical life of beings other than ourselves, except in so far as we may presuppose them to be wholly analogous to us, since no one has anything at his disposal other than his own soul by which to represent what may pass within a foreign one. And if, with regard to animals, the circumstance is of some advantage to us that, standing on a higher level, we may well believe ourselves to encompass what belongs to them on the lower, it is nevertheless another matter whether a lower level, such as animal sensibility, closes upon itself as a whole in its own right, or serves as the basis of a higher level and finds its completion only within the latter.

Let us therefore resign ourselves from the outset to the recognition that we can attain no more than approximately adequate representations of alien regions of soul. Meanwhile, an attempt may be of interest to carry such approximation as far as it will go.

II. General Assault on the Task

II. Allgemeiner Angriff der Aufgabe.

It is customary to deny plants a psychic constitution similar to that of humans and animals outright, on the grounds that the physical organisation and vital expressions of the former are not found to be sufficiently analogous to those of the latter. And indeed, the analogy of the physical is the only means available to us for drawing any inference about a psychic life other than our own, since it is a peculiarity of every soul that it can make itself known to any soul other than itself only through external or physical signs — signs whose interpretation, in the final instance, affords us nothing other than the analogy with that to which we find our own soul attached. Even those general philosophical reflections by which one might seek to resolve this matter must always rest upon this same analogy; for even if one wished to assign to plants a priori a certain significance and position within the organism of the world, one could still infer only from their visible, outward behaviour whether it is indeed they who correspond to that significance, and who represent the requisite members within the world-organism.

I infer that you possess a soul as I do only from the fact that you appear analogous to me, that you conduct yourself outwardly in an analogous manner, that you speak, and so forth — from form, structure, colour, movement, sound, all of them physical signs. What can I directly perceive of your

soul? I merely read it into all of these; entirely involuntarily, to be sure; yet it remains always something read in from without. Animals, it is true, already appear to us differently from human beings, yet they move, nourish themselves, propagate, and cry out in ways still similar to our own under similar circumstances; and though not all of them do all of this, they do several of these things. Accordingly, we still attribute to them a similar soul; we merely subtract reason, in consideration of the differences that do nonetheless exist. But in the case of plants, we at once subtract the soul entire; and if we are right to do so, this right can itself be grounded on nothing other than the fact that they are built too unlike ourselves and the animals that are analogous to us, and that they conduct themselves too dissimilarly.

Yet if analogy is here required, and must be required, in order to discover soul, one cannot demand it in every respect and without limit. Otherwise I should be justified in regarding any human being who looks or comports himself in some way differently from me as ensouled not at all. He is merely differently ensouled than I am. How unlike me in most respects is the worm, how differently does it conduct itself; and yet I still hold it to be ensouled — only differently ensouled than myself. The question, then, will be whether plants likewise fail to exhibit the essential signs of ensoulment, whether they are no longer analogous to us and to the animals in this regard. But which are these essential signs? What is the decisive circumstance that, in the transition from the animal kingdom to the plant kingdom, makes a sudden leap from en-

souled being to unensouled, or allows the one to pass gradually into the other?

I believe that the matter has been left conveniently unexamined, and that it has never yet been sufficiently discussed. For what has been advanced in this connection seems to me to have far more the character of justifying a preconceived opinion than of subjecting that opinion to a genuinely rigorous test. One abandons oneself in general to the seemingly decisive impression of mere appearance, which finds no soul in plants — because it can find none anywhere at all. In this manner, however, the sun long revolved around the earth, for direct appearance taught it so; who could doubt what every eye beheld? Yet now it is rather the earth that moves around the sun, after men at last resolved to shift their standpoint in thought. Precisely so it might perhaps suffice merely to shift our standpoint in spirit, in order to perceive the soul of plants from their own interior standpoint — a soul that escapes us entirely from our external one. But nothing is more difficult than to persuade a human being to transpose himself wholly out of himself into another position, and to seek there not himself, but that which belongs to that position. Where he does not find himself again, he believes he finds nothing.

In any case, merely because no one inquires rigorously after proof of the soullessness of plants, we are not therefore entitled to regard that soullessness as rigorously proved. In the attempt, however, to form sound views on this matter, we shall above all need to bring home to ourselves two things which ordinary reflection entirely forgets, thereby surrendering itself wholly to a certain bias. First: that from the fact that

we perceive directly not even the least trace of the soul of plants, there follows not even the least trace of an argument against their possessing one — since exactly the same amount would then follow against the soul of my brother and of every other being besides myself. And second: that even if plants look and behave so much more differently than humans and animals do, humans and animals already appear and conduct themselves so differently from one another that one not only may but must ask whether this difference might not extend still further without prejudice to ensoulment.

And indeed, to express at the outset the view whose substantiation is the task of what follows: upon closer examination, all that one might reasonably require as essential to the expression of ensoulment appears to me to be found in plants no less than in animals; while all the difference between the two in structure and vital phenomena is fitted only to remove plants into an entirely different domain of ensoulment — one that complements the animal kingdom — and not to place them beyond the general domain of ensoulment altogether. And if some deny souls to plants because they do not know what to do with them, I should require those souls, because without them a great unfilled gap in nature would seem to me to remain.

For — to touch first only cursorily upon a few principal points — the plant is still quite as completely organised as the animal, and organised according to a plan just as internally unified, an idea just as internally coherent; it is merely organised according to a plan of an entirely different character. One does not even venture to deny life to the plant; why then

deny it soul, when it would lie so much closer to hand, upon this common basis of life, to conceive of the different plan of bodily organisation as attended simply by a different plan of psychic organisation? What sense, in the end, does the concept of a life without soul carry? If the decaying plant appears dead to us, what is it precisely that distinguishes the living plant from it? Is the growth and flowering of a living plant merely a different mode of dead process from its decay? Is not the contrast between a living and a dead plant entirely analogous to that between a living and a dead animal? Yet is the significance of this contrast to be as wide as heaven and earth apart: the process of the living plant a soul-empty entanglement over against an equally soul-empty dissolution in decay; the process of the living animal all at once a soul-filled entanglement over against an empty dissolution? And yet the entanglement in the structure and processes of animal and plant is so wholly analogous. Even the fundamental cellular architecture is maintained in entire analogy in both; the cells are merely joined, grouped, elongated, and fused together differently in each — just as they already differ in every other animal, every other plant taken individually. The manner in which the entire cellular edifice arises from a single primordial cell through a similarly remarkable process of cell multiplication is likewise entirely analogous in both; indeed, what naturalist does not know that a seed and an egg are merely two different forms of the same thing? The mode of reproduction, too, is so analogous in both — so much so that Linnaeus was able to found the entire system of plants upon the analogy of their sexual relations. And the play of forces,

which has hitherto mocked all calculation according to the theorems of our physics and chemistry, is found again in both in complete analogy.

The nutrient substance rises with vigour through living plants, and its ascent can in no wise be compared to the slow and gradual absorption of fluids in dead plant tissue. Light exerts a significant influence both upon the ascent of the nutritive sap and upon the quantity of water evaporated through living leaves, and appears, on the contrary, to have no effect whatsoever upon these same organs after their death; in life, leaves decompose carbonic gas with the aid of light, while in death they do not alter it at all. The chemical transformations that take place in plant tissue during life are of an entirely different character from those produced in dead plants by external agencies; indeed, the latter are often the very opposite of the former. The elongation and broadening of growth, the orgasm that precedes fertilisation, and the awakening of active life in the embryo that slept, as it were, within the seed — these are so many phenomena that cannot be derived from any single purely physical cause, and which, instructed partly by analogy with the animal kingdom and partly by direct observation of plants themselves, we may ascribe only to vital excitability. (Decandolle, Plant Physiology, Vol. I, p. 19.)

And yet that which is so wholly analogous in the most general phenomena of structure, life, and activity is supposed to be wholly without analogy in the most fundamental matter for which we can draw our evidence from nothing other than these very general phenomena of structure, life, and activity — for let us remember, we have nothing at our disposal but

that exterior from which to infer this interior. Instead of grounding ourselves upon this most general agreement in the most essential points, we fasten upon differences in particulars and deny the plant a soul, because it does not also present all the individual features of animal life — which could at most justify the conclusion that its soul does not present all the individual features of the animal soul. The general must answer for the general, and the particular for the particular; yet as we now regard the plant, the difference in particular physical signs is supposed to signify to us a difference in the most universal domain of the psychical, and to decide between the being and the non-being of that very thing.

That souls may be organised according to the most varied plans and under the most varied forms is proved by human beings with their so diverse endowments and characters, by animals with their so diverse instincts. As rich as the abundance of bodily formations, so rich the abundance of corresponding formations of soul: the one is bound to the other. If nature has not exhausted with the animals the possibility of varied plans of structure and life in the corporeal realm, but has on the contrary added in the plants an entirely new kingdom of its own, what reason can compel us to assume that in the transition to these she suddenly fell into arrears in the creation of corresponding plans of soul, and that the possibility of such plans is, in general, less great than in the corporeal domain — given that we otherwise hold the realm of spiritual formations to be, if anything, richer still than that of material ones?

Do the phenomena of plant life perhaps, by their very nature, resist a psychical interpretation? But why, alongside souls that run, cry out, and devour, should there not also exist souls that bloom in stillness and breathe forth fragrance, that satisfy their thirst in the drawing up of dew, their impulse in the swelling of the bud, and a yet higher longing in the turning toward the light? I cannot see what privilege running and crying out should possess over blooming and exuding fragrance as the bearers of a soul's activity and sensation; nor in what respect the delicately formed and adorned figure of the neat plant should be less worthy to harbour a soul than the shapeless form of a dirty worm. Does an earthworm gaze upon us with more soul than a forget-me-not? Does its dark burrowing beneath the earth seem to betray more of free impulse and feeling than the plant's striving upward above the earth into the cheerful realm of light, its restless unfolding and outreaching? Yet to no avail are plants newly composed, articulated, adorned, and tended for us. Precisely where we see the arrangement made to win something wholly new in the kingdom of souls, and an equally careful arrangement beside it, we suddenly cease to honour this arrangement, and cast away an entire half because it does not look like the other. There stand the plants now like innumerable empty houses. Nature had material enough to build these houses, but no longer spirit enough to inhabit them. Having walled up dwellings for all animal souls, she no longer knew what to do with her surplus of cellular building stones, and employed the remainder in an apish pastime upon the empty plant-houses. But I believe rather that if she had ideas enough to

fashion the forms of plants, she had also ideas — that is, souls enough — to place within those forms; for the one must in the end depend upon the other.

One may perhaps say: well, if God's animating breath is diffused throughout all nature — a view which was indeed itself placed in the foreground above — then plants are not therefore soulless simply because they possess no soul of their own. The universal spirit breathes through them.

But how would it accord with such a dissolution into universal animation that each plant is so elaborately worked out in its every particular, and brought into so singular a form, as though something wholly specific were to occur within it, through it, and for it; that its form and manner detach themselves so distinctly and individually from the outer world; and that such weight is laid upon perpetually renewing and repeating itself, while otherwise all about it in this outer world forms and manners flow and change in indifference? Does not the plant thereby stand in relation to the wave dissolving in the ocean, and to the stone thrust hither and thither and conforming to every form and proportion, precisely as the animal stands — in which animal we can perceive no other signs of its being raised up from the ground of universal animation? Assuredly the omnipresent spirit will breathe through the plants as well; but only as it breathes through all other creatures too, who are not thereby deprived of their individual selfhood. This is God's most beautiful life: to weave within individual creatures. To allow plants to be merely pervaded by God's spirit in general makes them no more living than stone and wave, and robs God himself of a portion of his most vital

working. Does not our own spirit also live most powerfully and most beautifully in its most individual creations? Only that it does not attain to what the divine spirit attains — to generating spirits conscious of themselves and sensible of themselves. In this, God is indeed God.

In view of all this I ask: when one perceives in plants, no less than in animals, the expression both of an ideal interconnection and of an individual manifold of interconnected, pregnant vital phenomena, what more does one require in order to see therein also the signs and expression of a living individual soul — given that one cannot, after all, ever see the soul itself? Let it be plainly stated! Perhaps the plant is indeed incapable of giving more signs; but is it even possible in general to give more? Do there not perhaps lie herein already all possible signs, in so far as they are essential? Of manifold such signs one will not, from the outset, expect a great profusion for the simple fundamental fact of ensoulment, since everything specific must serve to express specific modes of ensoulment.

I believe the oak could readily turn back upon us all the arguments which we may direct from particular standpoints against its soul, and direct them against our own. How freely it drives forth branches on every side, bringing forth leaf after leaf and adorning itself with new growth born of itself alone. We merely put on outward adornment and must leave our body as it already is. It too might hold that nothing of soul could be bound up with this. We roam freely through nature; it does not. We act more upon other things than upon ourselves. But does the irregular drifting of a down-feather in the

air speak more for its being ensouled than the steady working of a being from a fixed standpoint; does acting upon another speak more than acting upon oneself? Yet if we know that we do not drift soullessly like the down-feather, how do we know it? Only because we ourselves are these beings. And if we do not know of the plant that it itself feels the impulse it drives forth, why do we not know it? The answer lies just as close at hand: because we ourselves are not that plant.

For the same reason, the plant might equally regard our activity in the world as meaningless and soulless as it regards that of a quill pen. To be sure, were it possessed of reason and powers of observation, it might discern our actions directed toward certain ends, our conduct according to particular rules, and might find that our behaviour does not depend so purely upon the accidents of external impulse as the motion of the pen. But if this be conceded, the advantage lies with us; for does not the plant too strive after certain purposes, according to determinate rules, independent of external and contingent influences? Yet there will be a far greater inclination to turn its behaviour according to fixed rules against the supposition of its ensoulment. Let us leave this for now; I shall return to it later (VII).

Is it not already the most common of all sayings, that it is the soul which builds the body as its own dwelling? Nothing, however, affords a better illustration of this saying than precisely the self-constructing plant, in which we can recognise the inwardly building nature only through the outwardly visible design of its structure; as is equally the case with the construction of man and beast. Indeed, the plant furnishes a still

better example than man or animal themselves, whose soul builds the body only in secret darkness and emerges into the light only when the edifice is nearly complete — which is why we are inclined to believe that the soul accomplishes this work only in dim unconsciousness. How different the plant. It brings nothing ready-made with it, but begins in earnest to build only after it has stepped into the light, continuing to create in the midst of, and indeed in consequence of, all the changing stimuli of life — even that which it prizes most highly, the blossom. For this very reason, however, we must not seek to compare the life of the plant with an embryonic life, as some are wont to do. On the contrary, it is evidently the intention of nature that there should be souls which conduct their lives more in the fashioning and shaping of their own organs, and others which conduct theirs more in acting outwardly through those organs once formed — a perspective of mutual complementarity in their modes of life, which will later (VIII) furnish occasion for further reflection, and which I therefore leave here.

It seems to me that in our judgement concerning the position of plants in nature we are no wiser than the North American savages who, instead of distinguishing masculine, feminine, and neuter gender in their language, distinguish between animate and inanimate objects, but then reckon animals and trees among animate beings and herbs and stones among inanimate ones. How absurd, we say — we who fancy ourselves so much wiser than savages — to place the boundary of life between trees and herbs, merely because trees lead a larger and longer life than herbs. How absurd, a spirit

standing somewhat higher than the sages of the Indo-Germanic linguistic family will say, to place the boundary of ensoulment between animals and plants, merely because plants manifest their soul in a different manner than do animals.

Young children, when they are small, will commonly refuse to allow that a goose is a bird. The goose, after all, neither sings nor flies. And what are we but such small children, when we refuse to allow that plants are ensouled beings, merely because they do not speak and do not walk?

Peasants see ghosts by night, despite none being there, because from childhood they have heard of ghosts that wander after dark. And what are we but such peasants, when we refuse to see the ghosts by day that stand there in bodily presence, because from childhood we have been told that none are there? In truth it is the same superstition, merely operating in opposite directions — to wish to see ghosts by night that are not there, and to refuse to see by day those that show themselves in plain reality.

A philosopher who sets out to prove against us that plants possess no soul will naturally find this no difficult undertaking. Since most philosophical systems have themselves arisen in part upon the assumption that plants have no soul, it follows naturally that from most of them that conclusion may again be derived. It is well enough known that, however much philosophers may give the appearance of demonstrating everything a priori, they could themselves have attained this elevated vantage of proof only by ascending from below. But in that ascent from below they are determined far more by

the prevailing common opinions encountered there than they are willing to acknowledge once they have reached the summit; and the agreement among philosophical views on the point in question therefore proves no more than the agreement of common opinion upon it, to which I shall presently turn. Of course, any system that requires the absence of plant-ensoulment in order to be cogent must also find supporting grounds for it within its own coherence; but what, in the end, is proved by all such grounds, when another coherent framework can be established which on its part requires the ensoulment of plants in order to be cogent, and likewise discovers grounds accordingly? In the last resort, the question will be which system is more cogent on other grounds. That our own — which is capable of living subsistence by animating a living world of souls — will take on a more beautiful form than opposing systems which bury this entire realm of souls in night, may be apparent from the outset; and though beauty is not the weapon by which common truths prevail, yet in virtue of the connection between the true and the beautiful in the highest domain, it counts among those by which the most universal truths do prevail.

Philosophical objections raised from the standpoint of alien systems can therefore carry little weight for us in general. A single example may suffice to illustrate such objections and to dispose of them, insofar as this can be done briefly; for we have no wish to be false to our resolution to avoid philosophical disputation rather than to lose ourselves within it.

A philosopher, for instance, on the basis of some prior series of reflections, sets up a kind of schema of how vital force,

soul, and spirit relate to one another — the latter two of which he habitually distinguishes more sharply than life itself does. This relation presents itself to him under the aspect of a certain graduated ascent, and as he requires the various levels to be represented in real nature, the plant kingdom falls of its own accord upon a level devoid of spirit and soul. Man, as the summit, represents the totality of all lower levels, encompasses them and closes them within a higher synthesis. Accordingly, beyond vital force and soul he possesses spirit or reason as well. The animal, a step lower, must content itself with vital force and soul; the plant, a step lower still, with bare vital force; the crystal lacks even vital force, and is utterly dead, surrendered wholly to mechanical process. The schema is clear and neat, and presents itself very handsomely — though I do not therefore claim that it is the schema of all philosophers; each may have his own; but it matters little, for it all amounts to the same thing: nature follows none of them. And one example serves as well as another. Holding to the one given, I maintain that the schema of an unsouled vital force has itself first arisen from the assumption of an unsouled plant-world, and has no other root whatsoever in reality; one cannot therefore wish to prove backwards from that assumption the existence of an unsouled plant-world. If one abandons this assumption, nothing is lost; one merely gains soul where before there was none. Plants will no longer be subordinated as soulless beings beneath animals; they will be placed alongside them as a different kind of ensouled beings, or subordinated only in the manner of ensoulment, wherein there remain in truth possibilities not exhausted within the

animal kingdom, as will further be shown. The schema will become something other than the above, and if we but order it accordingly, may present itself as handsomely as the above. Yet the possibility of a different schema must not lead us to accept it forthwith as correct without examining whether the actual behaviour of plants corresponds to it; especially since I believe that here a strict schema, a pure graduated super- and sub-ordination, is not to be spoken of at all. The very neatness, precision, and elegance that reside in the schema given above speak against its correctness; for daily and hourly does nature make evident to her student that her own neatness, precision, and elegance are of a kind that will not accommodate itself to his.

Perhaps it is precisely certain philosophers who most readily concede a soul to plants; yet they do so only by stripping the soul of everything that makes it a soul. For nothing is more common in philosophy than wooden iron. When I speak for my part of a soul, of the individual soul of plants, I expressly do not mean by this an idea or ideal unity that I discern in the manifold of their structure and life, although such unity may and must point me toward the self-feeling and striving unity of their soul-being; but I demand this unity itself in addition. A soul shall not be for me a mere reflection cast into some other medium, but must bear within itself the flesh and fullness of living sensations and drives. Not what I have of it, but what I do not have of it, makes it a soul. The idea of what another might seek or find in me will not itself suffice me as my own soul. What good is it to the plant, then, if someone finds ever so much unity, ever so much idea, in its

structure and vital phenomena, and then wishes to say: in that respect it possesses a soul, if all the while the plant could neither taste, nor feel, nor smell anything for itself? That is not what I mean by the soul of the plant, as some mean it; it does not seem to me that this is well meant toward it. Nor do I mean it in such a way as though what we reckon to belong to the life of the soul were indeed present in plants, but only potentia, as the expression goes, latent, perpetually asleep. Sensation and desire that sleep are simply not sensation and desire; and if we may still call our soul a soul even in sleep, because it continues to carry within itself the conditions of sensation and desire awakening anew, then that could never be called a soul where no such awakening would ever be forthcoming. If, therefore, I attribute a soul to plants, I may well grant that this soul is as capable of falling asleep as our own, but not that it sleeps always; for in that case it would seem to me even more abusive to speak of the soul of plants than if I were to speak of the soul of a corpse, in which sensation was at least once awake.

Yet it is not only the philosophical views that turn against us in concert; the common views do so as well, and this agreement would seem at first glance to carry far greater weight than that of the philosophers, whose roots we ourselves believe to lie partly in the common views, though on the whole the influence is certainly mutual. Who among us is moved to think of a soul in plants? And if such a soul is here ascribed to them, most will regard it as an altogether idle undertaking. Now it is certainly not reasons developed by the understanding upon which this agreement rests; it is rather a

feeling that imposes itself equally upon all, and which no one can say how it came to him. But this very fact seems to indicate that it has come from nature itself, that reasons lying deep within the nature of the thing have pressed this view upon mankind so involuntarily and universally. Many things, one may say, and from various sides, may point toward what we unconsciously bring together without setting it out clearly in its particulars. But all the more securely may we build upon a view in whose formation nothing preconceived has played any part. It must flow from a higher source than that from which human error springs, and if anywhere, the proverb will hold good here, that the voice of the people is the voice of God. Does not the belief in the future continuance of our own soul seem all the more certain to us for this very reason, that it has had no need of the fallible mediation of rational argument in order to spread universally among all, even the most primitive, of mankind? Just as certainly, then, as we believe that our soul will one day live, so certainly must we also believe that a soul of plants does not now live. For both beliefs are of equally natural and spontaneous origin.

This mode of reflection carries great plausibility, and within proper limits it has its justification; yet one must exercise caution with it, lest a great deal of false belief should seek to vindicate itself thereby. One need only read in Moses and the Prophets, in Job and the Psalms, to find that the ancient Jews, who are regarded as the privileged instruments of divine revelation, for many centuries believed as little in a future life of their own souls as we now believe in a soul-life of plants; with death all was finished for them; and anyone who had

wished to speak to them of a life after death, of a resurrection, would no doubt have been held even more foolish than one who now speaks of the soul-life of plants. Was this, then, also the voice of God, so long as it was the voice of the people? But in due time the soul arose for them from the grave of Sheol; a more comforting belief developed and became the voice of the people, and this we now hold to be the voice of God. So too the soul of plants, which in our present belief still lies in Sheol, might in a future faith one day arise, and this belief might in time become the voice of the people and, as the more universal belief in which it is rooted, pass as the voice of God. Naturally, much else connected with this would also have to change, which I also confidently hope; for nothing is more desolate than our present view of nature, blind and deaf to all soul in nature, and therefore itself soulless.

The warning not to place too great a weight upon the prevailing agreement among us regarding the soullessness of plants will appear all the more cogent when we observe that what is common opinion with us in this respect is by no means universal. Many millions of Hindus and other primitive peoples truly hold plants to be ensouled, because they proceed from an entirely different view of nature. Now we may perhaps in all matters lying beyond the natural world be much wiser than the Hindus and those other primitive peoples, but whether it is not the other way around with respect to what falls within the domain of natural life remains a question yet to be answered.

Sakuntala says in the well-known drama: "I feel the love of a sister for this plant"; indeed she formally takes leave of a

plant.

In the ancient law-book of Manu, which still today enjoys an authority over all human law in India, passages such as the following are to be found:

Chap. I., 49. (p. 11.) "Animals and plants, encompassed with manifold darkness, have inner consciousness on account of former actions, and feel pleasure and pain."

Chap. IV., 32. (p. 124.) "Every householder must preserve something according to right and equity, without injury to his family, for all sentient beings, whether of animal or vegetable nature."

Chap. V., 40. (p. 168.) "Grass-plants, cattle, great trees, amphibians and birds, which have been destroyed for the sake of sacrifice, attain in the next world to exalted births."

Chap. XI., 143. (p. 420.) "If any one has unintentionally torn down fruit-trees, shrubs with many stems, climbing plants, or such as grow again after being cut, provided they were in blossom when he injured them, he must recite a hundred verses of the Veda."

145. "If any one wantonly and needlessly cuts down cultivated grasses or such as grow of themselves in the forest, he must serve a cow for a day and take nothing but milk."

146. "By these penances the human race may expiate the sin of the wilful or inadvertent harm inflicted upon sentient creatures."

In Meiners, History of Religions (Vol. I, p. 215), I read the following passage:

"The Talapoins in Siam extend the commandment, kill not and injure not, as fully over plants and over the seeds or

germs of plants as over human beings and animals, because they believe that everything which lives is also ensouled. They destroy a tree and break the branch of a tree as little as they would mutilate a human being. They eat no unripe fruit, so as not to destroy its seeds, and still less the seeds themselves. With this strict abstinence it does not seem to them unlawful to partake of that which has lost its life without their agency; even the flesh of animals." (From Loubere, Descript. du royaume de Siam. Amsterd. 1700. Vol. I, p. 81.)

I wish here only to make passing mention of the Hamadryads of the ancients, who, even if in later times they may no longer have signified a genuine belief in the ensoulment of trees, could surely only have arisen from the presupposition of such a belief. For primitive man, everything in nature is, as a rule, ensouled. The Egyptians, too, worshipped plants: "Quibus haec nascuntur in hortis numina," says Juvenal (Sat. XV.).

Carus is therefore wrong to say (Psyche, p. 113): "neither in our language nor in any other has there ever been any mention of a soul of plants."

Nor, among us moderns, are there altogether lacking examples of those who believe in a soul of plants.

Percival regards the capacity of plants to extend their roots toward the place where they find the most suitable nourishment, and to direct their leaves and stems toward the light, as an act of will, which cannot be conceived without sensation. (Transact. Soc. of Manchest.)

F. E. Smith likewise holds that sensation cannot be denied to plants, nor, as a consequence thereof, a certain degree of

felicity, insofar as they execute movements in response to a stimulus — as, for instance, in their leaves and stamens. (Smith, Introd. to botany. 2nd ed. 5.)

Bonnet, Vrolik, F. Hedwig, and Ludwig also incline toward attributing sensation to plants.

Martius ascribes to plants not only a soul, but also the immortality of that soul. (Martius: Die Unsterblichkeit der Pflanzen, ein Typus; Reden. Stuttgart. 1838.) — I am not more closely acquainted with this work.

How, after so many and so loudly speaking voices of the peoples, could we still regard our own dissenting voice as infallible? But there is yet a further consideration: we ourselves give the lie to this dissenting voice through another, affirmative voice within us — and one which may be regarded as far more a voice of nature than the former — I mean the voice of poetry and of a feeling heart. While we deny the soul of plants, we nevertheless continually employ in poetry as in life images of plants as though they were ensouled; we feel ourselves intimately addressed by their life. We do not, it is true, believe it with our understanding; and yet, in spite of this disbelief, much within us expresses itself involuntarily in the spirit of such belief, and would do so still more freely were we not always of the opinion that it is after all an error. And now I say: it is rather nature herself that continually breaks a path through our received and inculcated representations. For in truth these representations are something instilled, and instilled moreover on the basis of a manner of regarding nature that lies very far from the original and immediate mode of apprehending it; they have not, however, grown out of that

mode itself — as the objection would have it, since otherwise such representations would have to emerge still more distinctly than among us in peoples who stand closer to the natural state; whereas in fact the reverse is true. So much, indeed, must be conceded: that it must have been far easier, in moving away from this natural state, to lose sight of the soul of plants than of the soul of animals, since the analogy of the latter with ourselves remains far more direct and immediate; yet this is merely a favouring circumstance, not a decisive one, for the manner in which our feeling on this matter now stands. The impression of soullessness that plants seem to make upon us so immediately stems at least as much from the manner in which we have learned to regard them as from what they actually appear to be; and it is precisely through this mode of intellectual contemplation that we take from them what we ought by that very means to bestow — for it is the task of the spirit to find spirit even where the eye does not see it.

Indeed, how can we wonder that it never occurs to us to think of a soul of plants, when from youth up we have heard plants spoken of as though the question of a soul could not even arise? We condemn plants to soullessness in no other way than the Muhammadan condemns Christians to hell. What among parents, teachers, in the mosque, and in every street is accepted as a settled matter — how should a shadow of doubt concerning it enter the mind of the young Muslim? He sees damnation written upon the faces of the infidels. So we see soullessness upon the faces of plants. In Raff's Natural History (p. 12) I read at once, as the definition of a plant: "a

plant is a growth that grows and lives from the earth, but has no sensation and cannot move from one place to another." And even where the child is not instructed in such express terms, one nevertheless conducts oneself in such a manner that it readily perceives the distinction one draws between plants and animals with respect to ensoulment.

Let a mother say instead to her little daughter: Look, my child, the little flower also rejoices in the life that God has given it, just as you do, only in a different manner; all flowers have souls, if not so rational as those of human beings, yet truly lovely ones; and you must not pluck a flower out of mere wantonness. For a garland, or to bring someone a posy, you may do so; for the animals too have souls, yet God has nevertheless appointed them to be eaten by men; so likewise has He appointed the flowers to give up their lives in order to adorn the life of man; each must fulfil its appointed purpose. — Let the teacher say to the boy in school: Ensouled beings divide themselves, in the main, into two classes: those that are rooted fast in the earth — these are plants — and those that are able to move about upon it — these are men and animals. Plants are, to be sure, more unlike us than animals are; yet since they grow, come into being, and pass away in the same living manner, and since nature has provided as amply for the purpose of their preservation and propagation as for that of animals, and for still other reasons besides, we must regard them as equally well ensouled. Men have not, however, believed this at all times; see, children, in this respect we have advanced much further than those who came before us. — Let there be, in general, among those among whom the

child grows up, no more question of the soul of plants than of the soul of animals, and the thought will never occur to the child that plants might perhaps be without a soul — any more than such a thought occurs to them with respect to the animals most unlike ourselves. Already the mere word "animal" now serves as proof of soul. And what has never occurred to people in childhood will not occur to them as adults either, so long as plants continue to grow, to bloom, and to breathe their fragrance as they did in childhood. Such is man.

One therefore deceives oneself when one derives our present-day and local disbelief in the ensoulment of plants from some deeply natural source, on the grounds that one is unable to account for it adequately by rational argument, and that it has come upon us, we know not how; and one errs in finding it thereby justified. Many a thief comes in the night and robs us of what we rightfully ought to possess, and is not thereby in the right. And if we look more closely, we may yet be able to find the opening through which he entered.

First and foremost, as has been said, it is the influences of upbringing to which we owe that disbelief; yet there remains the question of what introduced it into that upbringing in the first place. In my view, the deeper, more remote cause of our present manner of regarding plants is to be sought in the fact that humanity, in its departure from the original state of nature — wherein, by an unbounded analogy, it still held the whole of active nature to be divinely ensouled and alive like itself — has overshot the proper goal and now draws the boundaries of analogy far too narrowly. Where all of nature is still regarded as divinely ensouled, it is far easier to acknowl-

edge individual souls as particular emanations of that universal animation than it is among us, where the divinely animating spirit has departed from nature, has risen above it, and left it behind, soulless. In doing so, it took the souls of the plants along with it; and were we not to feel our own soul, and were not the thread of resemblances to spin itself out so unmistakably from us to the ape and downward from the ape to the worm, we would deny the soul of humans and animals just as readily as we deny that of plants. For our present principle is to acknowledge as little soul as possible in nature. Science, art, religion, instruction from earliest youth onward have all been imbued with this manner of contemplating nature, and every sphere of belief and knowledge has felt the deepest incursion of it. To change this is to change an entire world. Let us remember, however, that the most developed understanding, merely with greater self-awareness, frequently returns to the condition with which the development of knowledge began; and so we must not place too great a weight upon our present way of regarding nature, despite the fact that it appears to us so advanced. Perhaps it is for that very reason all the closer to the point of turning back.

When humanity finally learns to comprehend that God, without any diminishment of His sublimity and dignity, is capable of entering once more into that nature from which, for primitive humanity, He had not yet separated Himself — entering it without thereby dissolving into its visible externalities and particulars, and without the individualities of His creatures being extinguished within Him — then, too, with the soul-substance diffused throughout all things, individual

formations arising from their common source will find readier acknowledgement once again. Yet we cannot at present rest upon such prospects; rather, it must first be the task to open doors and windows to them, and this little work is meant to serve as one such small window, in that it opens a view into a blossoming garden of souls.

It is in particular the foregoing reflections that incline me to lay almost greater weight upon those standpoints suited to alter the distorted feeling of mankind with regard to the station of plants in nature, than upon arguments developed by the understanding alone; for the view directed against the soul of plants, which we must here contend with, rests itself far more upon sentiment than upon clearly developed rational grounds. Nevertheless, we shall not be able entirely to dispense with the latter; and above all, we shall not be able to dispense with the examination of the counter-arguments, lest we allow them to retain their apparent weight — a weight they gain only because one adds to it the prepossession of a conviction already formed.

Of all these counter-arguments, I shall begin with the coarsest, which for that very reason may perhaps carry the most weight with the greater number of readers. Were we to leave it aside, it would continually lie across the path we wish to keep as smooth as possible, a stumbling block in the way. Certain philosophers will, to be sure, fly easily over it; yet certain natural scientists, accustomed to walking in nature rather than flying above it, will find it all the harder to pass.

Here is a summary of the objections still to be addressed in the following sections:

1) Plants have no nerves (III).

2) They possess no free, voluntary movement (VII).

3) They lack a central organ, and in general everything that would be required as the expression of a unifying unity of soul (XIII).

4) One sees them ruthlessly trodden down, mown, hewn, and abandoned altogether defenceless to every manner of destructive interference. It is repugnant to our feeling, however, to believe that this could be the fate of sentient beings (VI).

5) They appear so entirely calculated to serve the purposes of the human and animal world, placed in the service of an alien world of souls, that one cannot seek in them an independent soul and self-directed end as well (X. XI).

6) If even the animal-like plants yield only ambiguous signs of soul, then in the case of true plants there can be no longer any question of soul at all (XII).

7) It is altogether impossible to form any adequate conception of a state of soul lower than that of animals and yet distinct from it (XIV).

The principal standpoints from which the resolution of these objections follows are briefly brought together in the concluding résumé.

III. The Nerve Question

III. Die Nervenfrage.

It is undeniable that were one to discover within plants those albuminous threads called nerves, the difficulty of conceding to them a soul would, for many, appear greatly diminished. To be sure, the inference that nerves are necessary to the soul is itself derived in part from the prior assumption that plants, being soulless, possess none; yet it is not this circular reasoning alone that comes into play here, but rather, and more principally, the following consideration:

When one destroys the brain of a human being or animal — that organ which is, as is well known, composed of the finest nerve fibres — one thereby simultaneously destroys all the outward conditions and manifestations of their inner life; and likewise, by severing or destroying particular groups of nerves, one may abolish the capacity for particular sensations. But if animals, once their nerves have been destroyed, give no further signs of soul or sensation, then plants, having possessed no nerves from the outset, can have possessed no soul or sensation from the outset either. Nerves thus demonstrate that they are, at least in our earthly, mundane existence, essential conditions for being ensouled, or instruments through which the soul requires to express itself under the conditions of this present life.

Nothing may appear more compelling than this conclusion, and nothing can be less so.

I set the following argument against it: if I tear away or destroy all the strings of a pianoforte, a violin, or a lute, then the tones of those instruments are at an end; I may hammer and strike upon them as I will — nothing but disordered noise results; no proper tone, let alone a melodic or harmonic succession or combination of tones, can any longer be produced; and likewise, by removing particular strings, the capacity for particular tones may be abolished. Clearly, then, the strings are essential conditions for the production of tones; they are, so to speak, the nerves of these instruments. And from this it follows, by precisely the same reasoning as before, that the flute, the fife, and the organ are incapable of tones from the outset, and especially of melodic and harmonic combinations of tones, since they possess no strings from the outset.

The comparison is, in one respect, quite apt, inasmuch as we are here comparing a means of producing sensations objectively with a means of producing them subjectively, between which a certain correspondence may perhaps be assumed from the very beginning. The violin gives sensations to others through its playing; the body gives them to itself. The body is, so to speak, a violin that feels within itself the inner play of its own strings.

Now, however, when I observe that the flute does in fact produce tones — that it does objectively generate sensations — despite my elegant conclusion, and without possessing strings, I see no reason why the plant should not equally be capable of generating sensations subjectively without possessing nerves. Animals might well be the stringed instru-

ments, and plants the wind instruments, of sensation. In that case, the sensations of both would certainly have to differ subjectively in the same manner as the sensations produced by stringed and wind instruments differ objectively; yet in both alike there might be sensations equally vivid, and equally melodic or harmonically united into psychic wholeness.

It is in truth impossible to see why Nature should have at her disposal fewer varied means for producing self-felt sensations than our art has at its disposal for producing sensations felt by others — especially since Nature is in every other respect richer and more manifold in her means than we; and since we see elsewhere how Nature loves to achieve the same general end through the greatest variety of means and according to the most diverse principles. In human beings, quadrupeds, and birds, the organs of respiration form a tree turned inward; in gill-bearing creatures, one turned outward. We move forward by extending our legs; other creatures advance through contractions of the body, as do leeches; others propel themselves by the movement of cilia, as do many infusoria; and all of this proceeds according to entirely different principles. Yet the ideal end — to obtain by means of movement what life requires — is everywhere the same. Should Nature, then, have truly remained so rigid in binding spiritual organisation to corporeal organisation by the sole means of nervous threads? On the contrary, were she to appear to me, in this one instance, poorer and more helpless than is her custom, I should rather expect that alongside the animals, in whom she has carried out the plan of psychic organisation

with the aid of nerves, there must exist yet another domain in which she has carried it out by other means.

For what is there so marvellous in the albuminous substance of nerves that makes them alone fitted to be the bearers or mediators of psychic activity? The fibrous tissue of plants seems to me, if one is to insist upon fibres at all, equally well suited to this purpose; it will merely be better adapted to the constitution of plants, as albumen is to that of animals. All things must be considered in their proper context. On the sun there can be neither albuminous nerves nor vegetable fibre — all would be consumed by fire; perhaps there exist nerves of platinum. Perhaps there exist none at all; for nerves are assuredly only one means, within a given context, of organising sensations in a particular manner, a function that may elsewhere be discharged by other means. Even the body of a pianoforte without strings yields a rough sound upon being struck; indeed, every body whatsoever gives forth something upon impact; so too may every movement in the world perhaps bear something of a psychic character within it. The question then concerns only the conditions under which this element may be so arranged that its contribution does not merely dissolve into the universal divine life, but also redounds to the benefit of a particular creature. We shall have to enquire separately into those conditions; but it is from the outset highly improbable that nerves alone should be suited to this purpose, or indeed that the filamentous form should be in any way essential to it. If it is truly the case that the whole world is a bearer and expression of the divine spirit, one will have to ask where the nerves of God are to be

found; and when we observe that the distant celestial bodies are united into a self-contained system by light and gravity, without long cables stretched between them, we may with all the greater confidence attribute to the directly adjoining cells of plants a coherent activity of the kind that must be demanded as the expression of a soul's working, since the signs of mutually responsive forces are indeed plainly apparent in the entire structure and formation of the plant itself.

Alongside the preceding analogy one may place others of like import, and it may be of service to do so by way of a few further examples. We are here essentially referred to analogies, and though nothing can be conclusively proved by them alone, a counter-argument may yet be weakened by their means, and the manner in which this subject ought to be conceived may be illustrated in various forms.

The flames of our lamps and candles burn by means of wicks, twisted from threads. So too do our soul-flames. The sun, a gas-flame, burns without a wick. So there will surely be soul-flames as well that burn without wicks of thread. Candles and lamps with wicks have their convenience, to be sure — they may easily be carried anywhere; gas-flames cannot. But do gas-flames burn the less brightly for that, and do they not have their own advantages in turn? Thus animals are portable soul-lamps, and plants are stationary ones. Why should the world be illuminated by portable lamps alone? Every great hall is lit rather more by fixed than by portable lights; and the world is the greatest hall of all. And in truth we may compare souls quite properly with flames, since without them the world would be altogether dark. It is again the

same comparison of the subjective with the objective as in the case of the instruments of tone. How many means there are for providing and sustaining objective light; and yet we would confine Nature, in the freedom with which she provides and sustains the subjective light of the soul, so entirely to that narrow means of the nervous wick?

The garden spider catches her prey by means of a net of fine and lengthy threads; without the net she knows how to catch nothing. Our soul is not unlike this. Only by means of a net of fine nerve-fibres is she able to catch sensations, in that she listens to what from the outer world touches these threads. But must all spiders therefore employ such a net to catch their prey? By no means; there are those that seize it directly from an ambush. So too might the plants know how to grasp their sensations immediately, without any nerve-net. When we do not see the spider in her hole, and see no net, we are of course inclined to suppose there is merely a hole and no spider there. But the net does not make the spider; rather, the spider makes the net, or indeed makes no net at all, and may nonetheless be a spider still.

When someone sits in a carriage and is driven, one need only cut the traces by which the horses are connected to the carriage; the carriage will then stand still, while the horses run off who knows where. But does it follow from this that a reasonable governance of the horses — which I here compare to the governance of the body by a soul — is possible only by means of long traces? This will be necessary only insofar as the driver sits in a separate box, as our spirit sits, so to speak, within the box of the skull. But let the driver seat himself

upon the horse itself, and he requires only short reins that scarcely catch the eye; indeed, if he has accommodated himself to the horse properly with knees, crop, and tongue, he requires no reins at all. Thus the plants too might be creatures in which the rider of the soul sat immediately upon the very frame of the body he commands, while in us he acts upon it first through traces from a separate part.

Analogies of this kind could be multiplied without end! And why should they, drawn as they are from the general substance of nature, be compelled to yield to the most narrowly restrictive analogy, according to which one misses a soul in plants because one misses nerves — that particular instrument of the soul — within them? One may, however, bring a far more direct consideration to the aid of these analogies.

We observe that breathing, the circulation of fluids, metabolism, and nutrition proceed in animals only with the assistance of nerves — the so-called ganglionic nerves; in plants no such nerves exist, and yet breathing, the circulation of fluids, metabolism, and nutrition proceed no less fully than in the animal; indeed, the whole life of the plant is held to consist in precisely these functions. But if the plant can breathe and nourish itself without nerves, why should it not also feel? Here one sees with the utmost clarity — nay, irrefutably — that in plants much that in animals is lodged in the activity of nerves has been transferred to other means. To be sure, plants lack not only the ganglionic nerves but also the cerebral and spinal nerves — the cerebrospinal nerves — and it is to the activity of these that one is accustomed to attach the

activity of the soul. Yet if something visible occurs in plants without ganglionic nerves that in animals occurs only with ganglionic nerves, why should there not also occur in plants, without cerebrospinal nerves, something invisible that in animals occurs only by means of such nerves?

More precisely, we are accustomed to regard the nervous system as serving the purpose of containing and conducting some fine, imponderable material substrate or agent — that which forms, so to speak, the intermediate link between the soul and the grosser body, by means of which the impulses extend from the soul to the body and the sensations return from the body. I wish neither to defend nor to refute this conception here; but if we allow it to stand, there is no embarrassment whatsoever in finding the activity of just such an agent at work in plants as well, even without nerves. We do not in the first place understand at all how the plant manages, with its comparatively simple cellular structure, to produce starch, sugar, tannin, acids of the most varied kinds, alkaloids, aromatic substances, pigments, poisons, fats, resins, mucilages, and so forth, from inorganic materials; each plant produces something different with a different structure, and we cannot in any way comprehend how another arrangement of cells, fibres, and tubes could bring this about — a certain proof that something more than mere fibres, cells, and tubes is operative here. That this something more does indeed reside at least in part in a fine imponderable agent is suggested by the circumstance that even in the ordinary chemical phenomena occurring outside the organism such an agent plays a role; electricity is in part generated thereby, and in part the

electricity thus generated reacts upon the chemical process itself. And so there will be no difficulty — rather, there will be the strongest inducement — to presuppose the activity of such an agent also in the extraordinary chemical phenomena occurring within plants; an agent whose character, or whose mode of activity, may differ from the agent governing ordinary chemical phenomena only as both kinds of phenomena differ from one another. There is indeed reason to believe that the generation of the nervous agent, whatever its nature may be, in animals is connected with and reacts upon the chemical processes taking place within them; so that the structure and arrangement of the nervous system appears to be of significance only for the distribution and dissemination of this agent.

Thus the conditions for the generation and activity of such a fine agent — capable of serving the soul as an intermediate link, if one wishes to require such a thing — are no more wanting in the body of the plant than in that of the animal; only the conditions for its regulated distribution, as the ordered activity of a soul demands, might seem to be absent along with the nervous system. But since we do not in the slightest understand what makes the nerves themselves suited to conduct the putative nervous agent in isolation — indeed, this remains until now scarcely explicable — the spiral and other fibres of the plant may be equally capable of conducting a similar agent in isolation, should such conduction be needed, in a sense analogous to that in the animal, which we must still regard as highly questionable.

At bottom, the entire assumption of an imponderable agent within the nerves is but a hypothesis, from which we may indeed infer with a certain probability from observed phenomena; there is however no interest here in founding anything upon it, but only in showing that, if one wishes to found something upon it, the plants possess within themselves the conditions for an ordered activity of this agent — such as one may deem necessary for the soul — no less than do the animals; and if one wishes to substitute the activity of other forces for that of such an agent, an analogous consideration will always be transferable to that case as well.

Rather than laying as a foundation hypotheses concerning something of which we know nothing whatsoever, it would in any case be best to reason backwards from outcomes that lie plainly before our eyes. We see, after all, quite ordered outcomes in plants. The fluids flow in a determinate direction; the blossom rises above the plant according to certain rules; the leaves are set at their periphery according to a certain rule; certain rows of cells fill themselves in regular sequence with these substances, others with those; one need only observe, on many a variegated petal, the entirely regular patterns which demonstrate that the coloured fluids follow quite determinate paths, or that the processes of coloration are specialised in a quite determinate manner. All of this surely speaks for an ordered activity of forces, whatever these forces and their bearers may be called; in this respect the plant yields nothing to the animal; indeed each plant follows a different order from every other, just as each animal with its different nervous system does, notwithstanding that the plant

has no nervous system at all. Therefore, instead of concluding from the absence of nerves to a lack of order among the forces prevailing in the plant, however they may be named, one ought conversely to conclude from the presence of order to the ordering conditions of these forces, and not thereafter allow oneself to be troubled by the fact that one does not yet know these conditions more precisely. In this one can see only a proof of our ignorance, not of their absence.

I shall not lay weight upon the fact that in certain lower animals, and in particular the polyps, to which no one has hitherto hesitated to attribute sensation and voluntary movement, no nerves have yet been able to be discovered. Unquestionably the rejoinder would be made: they will be discovered in due course; they are simply too delicate, too transparent, too isolated, for it to have proved possible until now. This may indeed be the case. I have neither reason nor interest to doubt it. The same evasion would then remain equally open in the case of plants; but I am far from wishing to employ it — nor is there any need to do so — for the view that sensation is possible only by means of nerves rests, taken as a whole, upon nothing more than an arbitrary hypothesis or the following fallacy: because nerves are necessary for sensation in animals, they must be necessary for it everywhere. What objection can be raised if I oppose to this the contrary inference: because plants have no nerves for sensation, they will possess something else for that purpose? One inference is worth precisely as much as the other — that is to say, neither is of any value in itself; everything depends on how far it can be further supported.

One might consider — and indeed, particularly in earlier times, much thought has been given to the idea — making the spiral fibres (spiral vessels) of plants into representatives of nerves. Oken says outright in his Naturphilosophie, Vol. II, p. 112: "The spiral fibres are to plants what the nerves are to the animal. They may with full right be called plant-nerves, and I rejoice in being able to invest them with this right. They condition the movement and stimulation of the organic processes," and so forth. For my part, I do not believe that, given the wholly different organisational plan of plants in comparison with that of animals — a plan which, as may later emerge, is in certain respects precisely the reverse — one can speak of any true representation of nerves by any organs whatsoever; every analogy will remain highly incomplete. Since, for all their difference, there must nonetheless exist some point of agreement between the two organisational plans, it may always be said that the spiral fibres are that in plants which most nearly corresponds to the nerve fibres in the animal; even should this correspondence prove to exist in a lesser degree than that between the pipes of an organ and the strings of a pianoforte, which in a certain respect, as tone-producing bodies, do indeed appear to correspond perfectly in both instruments, yet which from another point of view correspond not at all — since the solid body of the pipe is not itself the element that produces the tone in the organ, whereas it is precisely the solid strings that do so in the pianoforte; for the pipes merely sound somewhat in sympathy, impelled by the air within, while conversely in the stringed instrument it is the air that sounds in sympathy, impelled by the strings.

This impossibility of carrying the analogy through in a pure and consistent manner being duly taken into account, it may nevertheless always be of interest to pursue it as far as is practicable — that is, as far as the data for doing so lie within experience itself. And thus one finds, in particular, the following points of comparison between spiral fibres and nerves.

The spiral fibres, or spiral vessels, of plants are formed, like nerve fibres, by the fusion of cells arranged in series, and represent, like these, essentially fine tubules — with the distinction that in their fully developed state they carry only air, whereas the nerve fibres or nerve tubules appear to contain a fluid substance. The spiral fibres extend through the plant in a continuous and unbroken connection; they never branch, but the larger bundles merely give off smaller bundles by the deflection of individual fibres from them. Their position is central with respect to the other types of fibres and cells of the plant, each bundle of spiral fibres being enclosed by such elements, and in particular by elongated cells (fibres) — just as in the animal it is principally vessels that run in the neighbourhood of the nerves. The number and arrangement of the spiral vessel bundles is characteristic and significant for each plant, the structure of the whole standing in intimate connection therewith; they appear, in general, the more powerfully developed and the more closely consolidated, the higher the grade upon which the plant stands, while in the lowest plants nothing of the kind has been possible to discover. An important function must surely be attributed to them by virtue of their peculiar structure and their position within the plant; yet, as with the nerves of animals, this function expresses it-

self in no material performance in any directly clear manner. The specialist plant physiologists are of the most varied opinion on this subject, and the most circumspect among them acknowledge that we know nothing about it.

Goethe says of the spiral vessels in his notice of the Recherches sur la structure intime etc. by Dutrochet (Collected Works, Vol. 55, p. 11): "The spiral vessels we regard as the smallest parts which are perfectly identical with the whole to which they belong, and which, viewed as homeomeries, communicate their peculiarities to it while in turn receiving from it their own properties and determination. A life of their own is attributed to them — the power to move individually, in and of themselves, and to assume a certain direction. The excellent Dutrochet terms this a vital incurvation. To approach these mysteries more nearly, we find ourselves not further prompted here."

We too find ourselves not further prompted here to approach these mysteries more nearly. One sees in any case that the mystery of nature here presented, like all mysteries of nature, is not wanting in curious interpretations.

Let us now, in the two sections that follow, set against the anatomical point of view certain teleological and aesthetic perspectives which, though briefly touched upon in the general preliminary discussions (under II.), could not there receive their full development. However little that is strictly demonstrative one may ultimately find in considerations of this kind, the more does it seem to me that they contain what is genuinely persuasive. At all events, it was in the following

manner that the conviction first formed itself within me and came to its decision.

IV. Teleological Grounds

IV. Teleologische Gründe.

I once stood on a hot summer's day beside a pond, watching a water lily that had spread its leaves smoothly over the surface and was basking in the light with its blossom fully open. How extraordinarily pleasant it must be for this flower, I thought, plunging upward into the sun and downward into the water, if it feels anything of sun and bath at all. And why, I asked myself, should it not? It seemed to me that Nature would hardly have constructed a creature so beautifully and so carefully for such conditions merely to present it as an object of idle contemplation, especially since thousands of water lilies bloom and fade without anyone ever beholding them; far more compelling to me was the thought that Nature had built the water lily thus precisely in order that the fullest pleasure to be drawn from bathing at once in the wet and the luminous might redound to some creature in the fullest measure, and be felt by it with the utmost purity.

How lovely, under such an assumption, appears the entire life of this flower. Having raised its open blossom above the water throughout the day, sometimes by several inches, it closes it at night when it has nothing more to seek in the light, bends it downward, and, if what I have read is correct, withdraws with it beneath the surface, only to emerge again from its moist bed each morning. The lotus flower is said to do the same, even descending so deep at night that one can-

not reach it with an outstretched arm beneath the water; in the morning it rises again, and as the sun climbs higher, it rises higher too upon its stem. We no longer believe in water nymphs who sleep in the depths and ascend each morning to bask in the light; yet poetry itself, in conceiving such figures, acknowledged that such a life might hold its charms. Nature, it seems, knew this as well, and turned the poet's vision into reality. Not all flowers, it is true, rise and incline themselves in this alternation, though many others do; but need they all do so? Do they not already find sufficient pleasure in the budding of flower and blossom, in the enjoyment of dew, air, and sunlight, each in its own peculiar way?

So I continued to reflect that Nature had likewise built the mountain plant differently and placed it in a different setting precisely in order to bring to some being the freshness and purity of mountain air, and whatever else the mountain may offer that the pond cannot, for that being's purest and fullest enjoyment. For indeed, I said to myself, the water lily is truly fashioned in every respect for the water alone, and the mountain plant for the mountain alone; or might we not invert this and say that the water is fashioned entirely for the water lily, and the mountain entirely for the mountain plant? It is true that in the butterfly and the fish one already has creatures that enjoy a life in air and water; one might ask why others are needed. But how differently built, how differently appointed! Do not several species of butterfly already fly upon the same mountain, several species of fish already swim in the same water? Does one render another superfluous? Each, by virtue of its particular constitution and particular manner

of being, draws different sensations and impulses from the same element. Now the water plant stands in a wholly different relation to water than any fish, and the mountain plant in a wholly different relation to air and light than any butterfly; how entirely different sensations and impulses must therefore be possible for them as well! The very circumstance that the plant has a butterfly before it, and the butterfly a plant, already places each differently within Nature and renders different sensations possible for both; for when the butterfly drinks nectar from flowers, it cannot carry away the same sensation from this act as the flowers themselves. Or will one wish to argue that the sensation of the plant is thereby rendered superfluous and improbable simply because the butterfly already has its sensation in the matter? It would be quite the same as maintaining that in the commerce of lover and beloved the sensation of the one renders that of the other superfluous and improbable, when we see plainly that with equal participation in the living exchange each bears away an equally vivid side of sensation from it. If the contrast in the latter case is more intimate than that between butterfly and flower, this can entail nothing other than that it conditions a correspondingly wider contrast of sensation in the former.

This is, after all, Nature's greatest art in general: to allow each creature to draw something different from the same well, since the draught changes with the vessel. Every being represents, as it were, a differently shaped sieve, through which it accordingly strains different sensations from Nature; and what one leaves behind remains for countless others. However much the animal kingdom may have already appro-

priated from Nature all that it is capable of receiving, an equally great half no doubt remains for the plant kingdom.

And it seems to me by no means difficult to divine the principle of complementarity that governs this arrangement.

Man and animal run hither and thither, scatter themselves among manifold pleasures, encounter and handle all manner of things lying far apart. This has its advantages. But if we look only within the human realm itself, we recognise as well the one-sidedness of these advantages. Alongside wandering and travelling, the settled domestic life has its advantages too, advantages that must not be lost; there are many quiet and stationary spheres of activity that also wish to be lived through and felt through to their depths; but these advantages cannot be attained to the same degree simultaneously with the others, and whoever wishes to order himself truly toward the one cannot at the same time order himself toward the other. And so one man travels, while another remains bound to his patch of earth. As in the human realm, so in the realm of Nature. Men and animals are the travelling individuals of the world; plants are those bound to their patch of earth; the former destined to lay hold, through sensation and striving, of Nature's distant connections; the latter to exhaust, through sensation and striving, the circle of particular relationships within a given compass; they cannot, however, traverse this circle, since all running leads beyond the fixed standpoint, but only grow through it. Leave aside this second side of life, and one has omitted half of what is required in order that everything in Nature may be made use of.

We see how Nature allows not even a clod of filth to go to waste; three or four creatures will quarrel over it, every scrap and the scrap of scraps she turns to use, seeking in short to press utility to its uttermost limit — ought we not also to trust that she will have added stationary conditions of use to the ambulatory ones, since only stationary use together with ambulatory use yields the whole of use? An animal thrusts its nose only once into a place where a plant stands always fixed; it runs superficially over the earth in which the plant has grown deep; it breaks in only here and there, so to speak, along individual radii into the circle that a plant fills wholly and continuously; in the same proportion, however, it will be the less able with its sensation to exhaust the circle of those relationships which the plant must surely seek to exhaust, being once confined within it, and is capable of exhausting, being once ordered toward it.

Not long ago I watched my wife lift a plant together with its ball of earth out of a flower pot, and I marvelled at how the plant had so thoroughly and so finely penetrated every part of the earthen ball with its roots, having sought to savour every last particle of soil; and what was so below the earth was equally so above it. The plant had first spread outward in branches, and then filled the intervals with smaller twigs and leaves so that no scrap of air could pass through unexperienced; and at the tips of the branches it held, moreover, its little blue blossoms turned toward the light. This I commend in you, Nature, if only it truly redounds to the plant's benefit; but what vain toil and idle ornament it would be if flowers and trees grew merely as silent flourishes. It

would be labour for nothing — and this repeating itself ever and again in so many forests and fields. Were it for our benefit alone, it would surely have been more fitting if planks and beams, tables and chairs had grown in place of trees.

Now it gains its full significance for us, that plants press so closely together in space, while animals move singly back and forth among them. Space would not be fully employed if the stationary circles of action and sensation were to leave empty gaps between themselves; instead, they interweave and interpenetrate even as they stand side by side; but space would be equally ill-used if that which moves were to diminish its own room for movement; and so even one half of the animal kingdom devours the other, if only to clear the way again and again — and this very clearing is itself bound up with drive and sensation. In this manner nature develops and employs all her wealth, all her abundance, to the fullest possible degree. But her chief wealth consists, like that of a Russian estate, in a wealth of many souls that belong to the soil.

How sparsely distributed would sensation be throughout nature, once the plants were removed from the realm of souls — how solitary then, wandering only as a deer through the forests, or as a beetle flying about the flowers; and should we truly believe nature to be such a wasteland, she through whom the living breath of God moves? How different if plants possess soul and sensation; no longer standing in nature like blind eyes, like deaf ears, in her who beholds and feels herself as many times over as there are souls within her to feel her; how different for God himself, who surely per-

ceives the sensations of all his creatures in a concord and harmony, when the instruments of that harmony no longer stand at wide intervals from one another? Where would one tolerate such a thing at a concert of poor human beings — yet one expects to find it so with the rich God? Is it not more beautiful, greater, and more glorious to think that the living trees of the forest shine themselves like torches of the soul toward heaven, than that they give light only in death within our furnaces? And for this alone should they grow so splendidly upward? The sun itself cannot illuminate the world without souls that feel its shining. How dim with souls would the most sun-drenched forest be, if the sun were incapable of shining upon the souls of the trees as well. But if it is capable, then a forest is like a living blaze before God, helping to illumine for him his own nature. And when the tree is at last truly burned, there escapes in that final outward and visible flame only, as it were, what had glowed so long inwardly for God and for itself.

To be sure, we can only conceive of this after our own fashion; we see directly nothing of those soul-flames of nature; yet since we are able to think it, why should we not? Nor does anyone compel us to open our outer eye before outer lights, or to warm ourselves at outer flames. Why then do we do so? Because it pleases us so much better than to sit in the dark and the cold. Very well — in a dark and cold nature we also sit, if we refuse to open the inner eye of the spirit before the inner flames of nature. If it please someone better not to do so, who can prevent him? And yet how much there is that ought to prevent him!

Let us survey, as a connected whole, the entire cycle of a plant's life: how the saps well up within it so vigorously; how it is impelled to put forth buds and branches and to fashion itself unceasingly; how it strives with its crown toward heaven and with its root into the depths, by its own power, without anyone drawing it there or showing it the way; how it greets the spring with young leaves and the autumn with ripe fruit; sleeps a long winter and then begins anew to create; hangs its leaves in drought and raises them again in freshness; refreshes itself with dew; creeps about as a climbing plant in search of support — how the flower first rests quietly hidden within the bud and then a day arrives when it opens itself to the light; how it begins to breathe forth fragrance and enters into mutual commerce with butterflies, bees, and beetles; how the sexual impulse stirs within it; how it opens in the morning and closes in the evening or before rain; turns toward the light — and it seems to me that we ought indeed to find it difficult to think of this entire swelling and welling cycle, so rich in inner and outer change, as futile, barren, and empty of sensation.

These are of course not signs of the sensation of a human being, a cat, a sparrow, a fish, a frog, or a worm that we behold here; they are signs of the sensation of a fir, a willow, a lily, a carnation, a moss. But the inner life of plants is not meant to repeat that of animals, but rather to complement it. And is there not sufficient analogy in those life-signs, even with our own, to regard the plants still as our kindred souls? Were we only not so excessively proud of our legs, with which we run over them and tread them down, as if possess-

ing legs were already enough to outrun a soul in precedence. Indeed, could the plants run and cry out as we do, no one would deny them a soul; all those manifold and delicate and silent signs of soul which they offer up do not weigh with us as much as those coarser signs we miss in them; and yet plants are in all likelihood merely mute to us because we are deaf to them. We say of a plant standing in drought that it looks sad, that it languishes, that it pines. But should we feel more of that sadness, that languishing, that pining than the plant itself — we who may appear quite content, while it hangs its leaves and is on the point of perishing? By all signs it seems to touch the plant more nearly than it touches us. And why do we never say in the same way of an artificial flower that it smiles at us as a living one does, however closely it may resemble the living one? For no other reason than because we sense a truly smiling soul only in the one and not in the other. Christ rebuked the Jews who demanded signs and wonders in order to believe; are we not worse than the Jews, who truly behold the signs and wonders of a living soul, and yet refuse to believe in them? What more would we see in order to believe?

Let us now bring before our eyes and our inward sense one moment of that cycle more closely — the moment when the flower-bud is just opening.

How everything in the plant's life had been pressing toward this moment, and how it seems directed toward a powerful, sudden, glorious surprise for the plant, when, now bursting open, it receives in full flood, as a gift from above, into its open chalice what it had hitherto sought and laboured

toward only in the dark, without yet rightly knowing what was at stake — a foreshadowing of what will one day be received from the higher realm in return for our own labour toward it, when the soul shall break through our own bodily form as well. Or let us compare it now only with earthly happenings! Does the flower open itself toward the light in any way differently from that which also appears on the human body like a bright flower — as the eye opens itself for the first time to the light? Does it unfold its enclosed leaves, so tightly folded within the bud, in any other fashion than the butterfly unfolds its first enclosed wings, folded together within the chrysalis? One might suppose that nature has given us in the opening eye and the emerging butterfly a real sensation, but in the opening and bursting flower only outward signs of sensation; that it is we who first lay sensation into it through the act of poetic imagination? As if nature were not endowed with far mightier and richer and deeper poetic power than we, as if we could bestow upon her something which she did not already carry far more intimately within herself, as if all our own poetry were not itself first a faint reflection of her feeling, into which our own indeed enters as well, but does not enter alone. As much feeling as we may imagine in a flower coming into bloom, that much she most certainly possesses at least — indeed certainly more; everyone who does not merely feign a sensation has it deeper and fuller than another can read from his outward appearance.

Yet it is not my belief that sensation in the plant awakens only during the season of flowering — a concession which some, imagining themselves to be quite generous toward the

plant, have made on its behalf, adding moreover that the scant sensation which stirs to life in this way is an exceedingly obscure thing, darker perhaps than our darkest dream-images. But setting aside for the moment questions of intensity and clarity, why should I not believe that if the plant feels during the flowering, it also felt before the flower opened, when I do not doubt that the butterfly, which feels as a butterfly, already felt as a caterpillar? The plant in its pre-flowering state stands, in a certain sense, in a relationship to its future flowering state not unlike that of the caterpillar to the butterfly. It is only with the blossom that new senses and vital impulses awaken within it, impulses that overgrow all that preceded them, directing sap and force along new channels and toward new ends — whereby, naturally, its entire condition of life becomes something altogether different.

To permit myself a brief digression: flowers and insects, and butterflies in particular, are in general a remarkably apt parallel to one another, and at the same time each other's mutual complement — with the difference that the flower, in surpassing its earlier stage of life, retains that stage as a foundation beneath it, whereas the butterfly has entirely shed its earlier stage, or more precisely, has sublimated and absorbed it into itself. The plant-soul builds its body as a staircase, whose summit is the blossom, while the lower steps remain standing; the butterfly seems to soar above its earlier stage, yet carries it in truth up into the air along with itself, and by so doing elevates it to a higher mode of being, by reason of which it vanishes as the lower one it was. The caterpillar feeds upon the herb that is its image; the butterfly upon the

blossom that is its image. Thus it is that butterfly and plant together first complete their circle of life. A memory of the life beyond may once again be attached to this. The caterpillar finds what had occupied it in its lower state raised to a higher plane, in a higher realm of light; so too may man one day find the sphere of life in which he lived here lifted into a higher state; and as the butterfly is then free to wander over a thousand other blossoms, so perhaps it will one day be with us. The plant may feel pain when the caterpillar gnaws at its leaves — surely it thinks: wicked caterpillar! But when the butterfly comes to the blossom, it may be as sweet to the plant as it is to the butterfly itself. Had the plant not first nourished the caterpillar with suffering, the butterfly could never one day bring it joy. So we may imagine that what we in this present life sacrifice to others in pain, may one day in a future life be returned to us in bliss by angels. But were we to suppose that the flowers in the garden feel no more than paper flowers, then naturally there would be nothing in these or any other such beautiful images; these images would themselves be paper flowers.

How much in nature might go unrelished were not the plant's calyx the very cup fashioned to receive it, we who do not ourselves drink from those cups can scarcely begin to guess; yet enough lies open before us even from our own vantage point to allow some survey of it. Let us fix our gaze a little more closely upon a few points of that circle of life sketched briefly above.

What animal concerns itself with a drop of dew? It shakes the droplet off and takes shelter from the rain. We too com-

plain when we must wade through dew, and put up our umbrellas to shield ourselves from the rain; the plants, by contrast, are themselves put up like umbrellas to catch it — each leaf spreads itself wide for this purpose, and some even hollow themselves to gather it the better; only the blossom, destined more for a life in the light, is inclined to close itself against the rain, in order to open again all the more beautifully afterward; and the whole plant, after dew and rain, gives every sign of refreshment. But none of this signifies anything to us. What we call the refreshment of plants is supposed to be merely an embellishing expression for the swelling of a spongy cellular tissue; dew and rain supposed to exist only to make things disagreeably wet.

The farmer, of course, rejoices over the rain as well, for otherwise his harvest is lost; and we rejoice because the rain lays the dust and gives nature a fresh appearance — but this is only a mediated joy, and spares us not the question of whether there are beings that take immediate pleasure in dew and rain. Now the two fit together most beautifully. The farmer rejoices because the rain advances the flourishing of his crops, and thus becomes a distant means to his pleasure; well then, the crops will rejoice at their own flourishing directly and without mediation. We rejoice when the dust is washed from roads and fields — again a distant means of furthering our pleasure; what grows along those roads and upon those fields will rejoice immediately that the dust is washed from themselves.

Nothing hinders us from imagining — if sensation truly requires no nerves — that when the dewdrop rests upon the

plant in the morning, the plant feels it as a radiant point of coolness, and that when the sun rises and its tiny image shines within the drop, the plant feels this as a radiant point of warmth, and then feels how the sun little by little licks the dew away. A delicate play of sensation, impossible to any creature clad in fur — which is precisely why that fur shakes the dewdrop off, and why the plant hollows its leaves to hold it. The brilliance and splendour which the pearl-bedecked meadow presents outwardly to our eyes is, I think, merely the outward reflection of the inward joy of the soul that it contains. It is so much more beautiful to imagine that it is so — and yet I find not the slightest impediment to believing that it is also true. And why should we prefer to declare a soul's elixir to be mere water, when we are perfectly free to make of water a soul's elixir?

What is true of dew and rain may hold also for the wind. Far more of it would pass away in vain if the plants perceived no more of its blowing than we do. This is why they protect themselves by no houses, no cloaks, no sheltered corners, but stand freely in the open, bending and inclining, swaying and trembling in the wind. The very fact that they are rooted fast in the earth gives the wind a far more forceful purchase upon them than it has upon us; the trembling reaches down into the roots, and every leaf quivers and rustles. I believe that the plant may thereby receive a sensation considerably stronger than the one we feel when the wind passes through our hair. Our hair is a dead part of ourselves; but the leaves of the plant are living; our soft, flexibly jointed limbs are not as well suited to receive a trembling and conduct it through their

length as is the plant's stiff trunk or stem. We have only a small tympanum within us, stretched taut, set vibrating by the waves of air. The plant is from end to end such a tympanum, upon which the wind beats its drum; and if we hear the sounds outwardly in the rushing of the wind through the leaves of the trees, how differently may the plant experience this inwardly. Consider that no one else hears it when we chew a hard crust of bread, while we ourselves hear it with great intensity from within. Even in seemingly still air, when it snows, we see the snowflakes drift and waver up and down, hither and thither. How much of this movement of the air do we perceive? We have no organs for it. The plant, one may well say, is entirely organ for it; the slightest movement of the air produces in it a gentle trembling and bending that acts through the whole — for it is not only the trembling, but also the bending that does its work. When one small leaf is bent, a passage is at the same moment constricted, and the sap must flow differently through the whole plant, however slightly. When the wind rushes more strongly through the forest, even we ourselves are seized quite involuntarily by the feeling that the spirit of nature is rushing through it. And in truth the trees and flowers have become for us the strings of a great soul-harp that the wind plays. Every string sounds differently upon it, for each is differently formed to that end, and God shall perceive the whole concert within Himself.

Let us now turn our thoughts to fragrance. How sweet it seems to us; and yet shall all perfume be counted as lost that does not chance to enter one of our nostrils — that small portion of us — while the flower itself is entirely a vessel of in-

cense? Every person feels, no doubt, that there is something indescribably enchanting and lovely in the scent of flowers; yet for each of us it remains an indescribably peripheral matter. We sample more of its sweetness than we know how to enjoy; we cannot hold our nose above a flower for a single minute before we have had our fill and move on — while the flower continues to breathe its fragrance without ceasing, as though it had a perpetual office to fulfil. Is it a burnt offering, made to God? But what service can an offering render to God that is not brought to Him by a soul? All of it inexplicable, more than half in vain, if the fragrance of flowers exists solely for the sake of others and not for its own sake — indeed, far less for its own sake; if what we, who stand so wholly external to the life of flowers, enjoy of its sweetness is more than a distant echo of what is enjoyed within the life of the flower itself. Who has ever heard a sweet song sung, of which the singer felt less than the listener — above all when the listener is not a kindred soul? Must we not therefore also suppose that the flower, in the inward working and outpouring of sweet fragrance from its depths, feels with a greater intimacy than we feel in its outward streaming toward us? And now one calyx pours this fragrance into a thousand other calyces, and one calyx receives it in turn from a thousand others. Like an invisible mist, the fragrance drifts from flower to flower, and the wind carries it far beyond hedgerows and field boundaries. Is this, too, in vain? Does it not become fully comprehensible for the first time why flowers continue to breathe their scent while no one walks in the garden? They themselves go forth to one another by this means, even as they ap-

pear to stand motionless. Every flower-soul may, through what stirs at its window from the other flowers, receive an impression of what passes within every other flower-soul — as the words we hear awaken in us corresponding feelings akin to those with which others speak them. Words, too, are nothing but sensory messengers animated from within; why should fragrances be any less so? Words for us, fragrances for plants — which, to be sure, will not transmit anything so articulate as words; but is there only thought that passes into and through other souls, and no feeling? There are, it is true, flowers without scent — but are there not also mute animals? We see, admittedly, no special nose on the flower for the purpose of smelling; yet as it is built entirely as a calyx to pour forth fragrance, so it appears equally built to receive it again, spreading itself out for this purpose so freely, so widely, so openly, and so simply. Let us but consider that we do not in the least understand what enables the inner surface of our own nose to smell — why, then, should the inner surface of the flower not be equally capable of doing so?

In us and in the animals the organ of smell is concealed; in compensation, we have in the convoluted turbinate bones special contrivances for enlarging the surface receptive to odour. In plants no such artifice was needed, precisely because the entire flower lies open for the reception of scents. Whatever fulfils a principal purpose independently is always able to do so in a simpler, clearer form than what must subordinate itself as a secondary part to something else.

Smell leads us further to taste; and why should we not credit plants with this faculty as well, in their own manner,

since so much in nature would go untasted if the plants themselves did not taste it? Man and beast each consume only plants and other animals; the plant consumes all that men and animals do not desire, and indeed is most drawn to precisely what they most disdain. Here again, then, we have a mutual completion: if the plant is capable of tasting alongside the animal, then there is a whole; if it is not, then only a half. And we observe, furthermore, that each plant makes a selection among nutritive substances according to its own nature. Different plants absorb different things from the same soil; the practice of crop rotation demonstrates this on a large scale, and experiments by natural scientists have proved it on a small one. Not every plant finds the same things palatable, just as not every animal does. The plant, it is true, has no teeth and no tongue; but is not every root-fibre, every leaf with which it tastes and laps up nourishment, a tongue? For it is well known that the plant nourishes itself through its leaves no less than through its roots. And why should it chew its nourishment, when it knows how to master such nourishment without teeth?

One might object: does not the fact that the plant nourishes itself from dead, inorganic substances argue against its being capable of carrying away a living sensation from this process, as the animal does, which consumes substances already rendered organic? Plants merely prepare the dead for its transition into life; but this process itself still stands at the intermediate stage between life and death. To this I reply with a counter-question: does it not bespeak greater vital force to bring the dead to life than to transform what is already living?

The plant fashions from raw earth, water, air, and decaying matter a glorious form and colour; the animal has only the lesser task of transforming into itself a substance already so far surrendered to life. Yet we observe everywhere that the more foreign something is as it enters the organism — the greater the vital effort, therefore, required to overcome it — the more disposed it is to awaken sensation. Thus, I maintain, in contemplating the laws of our own organism, we have reason to seek in plants not less but rather more sensation in the assimilation of nutritive substances than we find in ourselves.

Let us turn our eyes once more, finally, to what may be the highest thing for the plant: the light. Our eye, too, is receptive to light; light would not go unenjoyed even if the plant enjoyed none of it. But how entirely otherwise may it be enjoyed by the plant, whose whole life culminates in a life of light? Who among us can gaze directly into the sun? Not the sun itself, only what it illuminates, do we dare to look upon. Indeed, when it shines upon the crown of our heads, we put on a hat or cap. It is broadly similar with the animals. Even the eagle, as it soars toward the sun, draws its nictitating membrane across its eye. But the flower opens itself wholly and completely toward the light — indeed, is opened by the light itself; the more the light shines upon it, the more it unfolds, while we close our eyes ever more tightly against it; and the flower thrives splendidly and joyfully within it, provided only that the refreshment of rain and dew follows in due course. Yet we persist in refusing to count all this as enjoyed. There are apparently to be only beings that look aside

from the sun, that are permitted to bask in the leavings of sunlight. I maintain, however, that whoever can only look aside from the sun thereby proves that its radiance is more of a peripheral matter to him than to one who would gaze directly into it.

It is true that the plant, again, has no eye constructed as ours is; no apparatus whereby an image of objects is formed within and upon it, as in our eye. But why should it need one? It has no need to run after objects, no need to reach out for them as we do; for that purpose we must indeed allow ourselves to be guided by an image of objects. Everything it needs comes to it of its own accord. Instead of rejoicing in the objects that the sun illuminates, it rejoices in the illuminating sun itself, while being at the same time itself the sun-illuminated object. Instead of allowing a coloured image of objects to be painted upon it, as happens on our retina, it paints itself in colour within the sun's rays, and embodies those rays, so to speak, within itself. Light becomes plant; it wrings colour from it; within the plant it is cooked into nectar and fragrance; it ferments, it swells — all things within the plant stir and surge; the plant is kindled by it into a heightened feeling of its own illumined existence, and becomes thereby simultaneously aware of the working of something supreme above it, within itself. Gazing into the sun, it beholds, so to speak, its God face to face in the fullness of His radiance; and the sun is indeed in truth a luminous eye of God, into which the plant gazes, and with which He gazes back upon it.

Already Schelling said: were the plant possessed of consciousness, it would revere the light as its god. Well then —

even if it possesses no consciousness as fully developed as our own, it may yet, in the ray of the sun, attain a feeling that elevates it above its accustomed sphere in the same way that the reception of the divine into the spirit elevates us. The following very beautiful observation I read in Hegel's Philosophy of Nature (p. 425):

In the evening, when one approaches a flower-rich meadow from the eastern side, one sees few, perhaps no flowers at all, for all of them are turned toward the sun; from the western side, by contrast, everything blazes full of blossoms. And in the morning on the meadow, when it is early and one comes from the east, one sees no flowers either; only when the sun casts its light do they turn themselves toward the morning. Is this not altogether as though the flowers of the meadow were holding a communal evening service, and then, still with their faces turned toward God, fell asleep? But God will not let them sleep on forever; they are ever to find their joy in seeking Him and in keeping pace with Him. And so He slips around behind them in the night and wakens them in the morning with a great universal radiance, asking: where am I? And each turns its head until it has found Him, and then walks with Him through the day.

It is true that not all plants gaze with their blossoms directly into the sun; how many there are that incline themselves; indeed, there are some that open in the evening and close in the morning or before the morning. One need only think of the Queen of the Night.

Yet it is also not to be supposed that every individual and every species in the kingdom of flowers attains the highest

summit of life in the light; even among human beings, only a few reach the highest of which their nature is capable. How few there are who turn their souls wholly toward God, how few will deserve one day to behold Him fully. It is sufficient that within the kingdom of flowers the opportunity is at least offered to attain the greatest and highest enjoyment of light, whereas it is offered nowhere else. Some flowers may be too sensitive to light, as certain nocturnal creatures are; yet the very circumstance that each flower behaves differently and in its own peculiar fashion in this regard, just as every human being and every animal responds in its own peculiar fashion to the stimuli of sensation, itself speaks in favour of the view that light is indeed a real stimulus for plants as well.

How much greater a significance light may have for plants than for us is apparent, beyond the orientation they assume toward it, above all from the fact that it intervenes so much more powerfully in their entire vital process than in our own. We do not grow differently, we do not breathe differently in light than outside of it. The sunbeam glides across our skin without leaving a trace or producing any effect; only the eye is susceptible to its stimulus. But the plant feels the stimulus of light across its entire surface, just as it feels the absence of that stimulus. It is light that causes the plant to turn green, it is light that causes it to flower; for without light all herbage remains pallid, and no blossom will unfold. Without light its transpiration stagnates, the plant ceases to give off vital air, the shoots become narrow and elongated and pale, and instead of strong, tart, and bitter substances only insipid and sweetish ones are produced. Each different ray of colour ex-

erts a different influence upon the vital processes of plants. Moreover, the blossom leads an entirely different life in light than does the green herb; it breathes differently within it, takes on colour differently within it, unfolds itself differently within it. Now we find in ourselves that the more important and necessary a stimulus is for the preservation and flourishing of life, the more the normal feeling of life, or the emergence of particular feelings of need related to the deficiency or excess of that vital stimulus, depends upon its proper measure, its lack, or its superfluity; the more decidedly, in general, is every variation of the stimulus perceived. We may therefore also presuppose that light will hold the most important significance for the sensation of plants, and indeed a significance of a different character for the blossom than for the leaves.

One might be inclined to argue that the very circumstance of the flower offering itself so openly and without apparent harm to the rays of the sun speaks most strongly against any considerable sensitivity to light on its part; for the fact that we are compelled to close our eyelids against the dazzling sunlight is regarded by us as the clearest sign of a great sensitivity thereto. But on closer inspection, what we must acknowledge in the case of plants is not a greater insensitivity but rather a greater protection of their sensitivity. In truth, the greater ease with which plants bear sunlight depends solely upon the fact that, for all their universally distributed susceptibility to light, they do not also possess, at any single point, such a light-concentrating apparatus as we have in the lens system of the eye. Since this apparatus concentrates the

image of the sun with force upon our retina, the sole point in us susceptible to the stimulus of light, we naturally experience a powerful dazzle; the plant presents itself to the light in a state of susceptibility everywhere and without such a burning-glass, but is for that very reason not so easily subject to the over-stimulation of a single point. We stand in a certain respect at a very great disadvantage compared with plants. For we have in large measure lost the capacity to sense light and have been reduced to a mere fragment of an eye; this fragment then required artificial assistance, and thus we obtained the lens glasses of our eyes; yet this assistance in turn easily becomes too much, and against that there arose the need for further artificial corrections. For the open, simple, and unencumbered commerce of the plant with light, by contrast, neither artificial means of concentration nor anxious measures of protection and correction were required. To be sure, the ingenious device of the eye is of further value to us beyond the mere gathering of light, serving also to order it into an image; but this value belongs to us alone, and would be of none to the plants.

After all this, one might object: but what then? Surely the most that could be claimed would be to attribute to the plant, which must in any case stand lower than we do, some faint echo of our sensation; and now it is proposed that it should feel so very much more strongly and richly than human beings and animals! Would it not therefore stand higher than we do; would it not be we ourselves who perceive only these and those faint echoes of what it perceives on all sides and in full measure?

And in truth I believe that the plant does stand higher than we do, only within a lower realm. Precisely because it lacks a higher life of the soul, the lower life, the life of the senses, may have attained in it a degree of development that is wanting in us. In us the life of the senses exists only to serve the higher life; in the plant it conducts its own business independently. One errs in supposing that nature places one creature in every respect below another. Even when it does so in the whole, it is only in order to raise the lower level into a summit of its own kind. Thus the tortoise surpasses the eagle in certain respects; it scents the water without seeing it; and the woodworm knows and perceives many things better than the human being; it exists precisely so that wood too may be tasted, toward which the tongue of man is dull. I believe that the plant lives in such constant and unimpeded communion with earth, water, air, and light, that it may well be entirely open to the sensation of all changes within them; and indeed all such changes truly do penetrate into its vital process. But just as all its activity does not reach far through space, so perhaps its sensation does not reach far through time; it does not think ahead or back or around itself, does not think at all, but lives along in the present, sensuously receiving and striving in response. Definite representations in formed images may likewise be wanting in it. I do no more here than indicate this position of the plants; more will be said of it and for it later, in the fourteenth section. What is certain is this: if we wish to preserve for plants only a few traces of sensation, then only traces will remain of the strongest and most beautiful reasons for their possession of a soul, and it would no

longer be worth the trouble to speak of the matter at all. For it is plain enough that these strongest and most beautiful reasons lie in the beauty and binding force of a coherent, rich, and living vision of nature, which arises in us when we are able to supplement human and animal life, complementing it at all those points where it leaves a gap, a void, and an incompleteness, with a fully unfolded life of the soul. And how great would that gap be, if the plant kingdom did not fill it. Only thereby does nature become a full and complete flower; yet we would tear from it all the abundance of its petals and leave standing only a few stamens. And even if it should be that we have perhaps sought somewhat too much in plants, this is but a fair recompense for the fact that one has so long sought certainly far too little in them.

V. The Character of Plants

V. Charakter der Pflanzen.

Every plant appears to us, when set beside another, in the light of an individual, living difference of character — a difference that is more readily conveyed by the immediate impression itself than it can ever be by words. Consider the auricula and the primrose: they are of one family, and yet each presents an entirely different face. Ivy and vine appear akin, and yet what differing characters they possess! And what of things still more remote from one another: a rose, a lily, a tulip, a violet; — an oak, a willow, a birch, a fir; — how distinctly each separates itself from the rest. And yet each is so wholly at one with itself in character, so entirely cast in a single mould. In one plant all is delicate and fine; in another all is luxuriantly full; in one all is strict and stiff; in another all is soft and yielding; one divides and divides again and divides yet again, ever reaching outward in fresh inquiry; another stretches itself straight and simply upward; in some there are contrasts present, yet these are bound together into a single general impression. But in the end no words quite reach it; and how many plants there are for whose character no word sufficiently apt presents itself to us, while yet that character impresses itself upon our feeling with the utmost distinctness in the moment of beholding.

There is in this something altogether similar to the expression of character in different human beings, so that quite

of itself the inclination arises to compare the one with the other. Thus the rose is compared to the blooming girl, and the blooming girl to the rose; the lily stands like a white angel among flowers, and the pure, angel-like girl we gladly compare in turn to the lily; so too the vain lady and the tulip, a modest child and a violet, a strong man and an oak, readily and willingly call one another to mind. (One thinks of Freiligrath's poem: The Revenge of the Flowers.) It would be vain, of course, to attempt to find all plant-characters mirrored in human characters, or the reverse; flowers and trees are simply not human beings; here and there a prevailing correspondence occurs to us, which yet neither fully expresses nor covers what is peculiar to either party; but this is not what matters — what matters is that the character-portraits of plants and of human beings should confront one another at all as equals in the whole, and with such vivid points of correspondence in detail.

Now, the expression of character in a human being is nothing other than the outward expression of his inner spiritual nature. The unity and individual particularity of the human soul gather themselves together in this expression, rise to the surface, and mirror themselves into another soul. How, then, should we come to assume in plants an analogous expression without something analogous that expresses itself; to find the unity and individual particularity of nothing here expressed; to behold a reflected image where there is nothing behind it?

It is said that what appears here is the expression, the reflected image, of a divine idea. Very well; but precisely of a di-

vine idea, with nothing behind it. It is the very fact that there is not merely something dissolving into the universal spirit, but that a self is present, which must be held to be declared by the self-livingly unfolding, shaping, and self-displaying character of the plant.

In truth the case is entirely otherwise with plants in this regard than it is with our works of art and our instruments. In these too, even should they represent nothing but lifeless things, one may certainly find something individually characteristic, something that makes them appear cast in a single mould; something fine, graceful, ponderous, bold, noble, or base, that calls to mind something spiritual or psychical of like character. But we know that this quality has been transplanted thither from the hands of the human maker; it bears the character of the human being because it has proceeded from that character. But the plant has made itself, or has been made by God, as the human being was; its expression of character can therefore refer not to a foreign soul, but only to a soul of its own, for God is the creator of souls that belong to themselves.

With this is connected the fact that the interest we take in flowers, in life as in poetry, is far livelier and more intimate than that which we take in a statue or a painting, however much these latter may lay claim to a higher and more purely intellectual interest. With what care and love many a girl tends her little flower in its pot upon the windowsill, watering it, washing the dust from its leaves, turning it toward the light, and questioning the gardener on how best to look after it; the cultivation of auriculas or pelargoniums gives some

people a joy akin to the pleasure others take in keeping doves. Statues and paintings may well adorn our rooms and cultivate our minds; but they cannot live alongside us in the same way. One says: it is the resemblance to what is truly living that misleads us; plants grow and put forth new growth; this looks like life; pictures and statues do not do so. And in truth this explains the difference, but at the same time constitutes it; it does not mislead us, but rather leads us aright. Precisely because the plant grows and puts forth growth livingly out of itself, while the painting and the statue do not — having sprung up only from a foreign hand — one may also presuppose this of them with respect to the soul: the soul that dwells in the statue is merely a borrowed one; the soul that dwells in the flower is its own. Nature has this advantage over the human artist, that her works of art — that is, animals and plants — are self-living things.

Everyone readily concedes that if the child were not just as full of life and feeling as the mother, the mother could have no living love and joy in it. And so it seems to me to lie within the same connection of things that we could not take so much soul-felt an interest in flowers as we do, were they not themselves possessed of so much soul; unquestionably, however, they possess far more of it than our interest in them reveals — for flowers are too distantly related to us for us to understand the expression of their soul as readily as the mother understands that of her child. Yet enough of it is present to allow the inference to be drawn for the greater part as well.

Will the intellect refuse to engage with all of this? Very well, then; we shall prove to it that it does so involuntarily nonetheless. Even philosophers, with no thought whatsoever of attributing an actual soul to plants, have illuminated the independently purposeful, characterful stirring of the human mind by analogy with that of plants — thus finding the expression of the one mirrored in the other. "Just as the plant," says Lotze in his treatise on the conditions of artistic beauty (p. 55), "develops all the parts of its form from its germ by an inherent formative impulse of its own, and clouds and winds can never make it into anything other than its nature destined it to be, so too does every individual mind rest entirely upon itself, a whole cast from the whole, which external influences may indeed draw into their vortex, but cannot alter in its essential core." — Very well, say I: if the mind stirs inwardly and from within itself as a plant does, why may not a mind itself be the very force that stirs within the plant?

And in the same work (p. 38) it is written: "With the same tendency of its formative impulse, from which the simple forms of the leaves arose, only upon a higher ground of its activity in general, the plant unfolds the more spiritual forms of the blossom and even the self-enclosed contours of the fruit; so too must every development in general be regarded as a gradual enrichment and deepening of an original idea within itself."

It would be easy to find parallel passages to the foregoing in other philosophical writings; these presented themselves to me unsought in my current reading. That they proceed from a writer who is accustomed to combining thoughtful

and perceptive reflection with sharply defined conclusions may speak in our favour, among other things, for the view that here too understanding and feeling meet in more than a merely accidental manner.

In man and beast alike, the characteristic physiognomy that distinguishes them is accompanied by an equally characteristic internal structure, a characteristic order and manner of vital processes. A different economy of the soul requires, in general, a different economy of the body as its expression or vehicle, and the general form of the figure indicates only outwardly, to the eye, the peculiarly cohesive and self-contained unity of this inner economy. And it is with the plant precisely as it is with man and beast. A human draughtsman may well execute all his figures, however characteristically various they may be, with hatching in the same manner; yet every distinct plant form, like every animal form, is inwardly hatched otherwise with cells, fibres, and vessels; the sap flows differently; the forces act differently. And such differences obtain not merely between distinct species — oak, willow, tulip, carnation — but even between individual members of the same species; less distinctly, to be sure, than between species, yet just as one negro differs from another negro, and one mouse from another, less distinctly than the negro from the white man, or the mouse from the rat or the lion.

Now if the body of the plant possesses everything that the soul requires in order to manifest itself both as a unity and in all its variety, why should the soul itself be wanting therein?

Of interest, in relation to the differences of character among individual plants of the same species, seem to me the

following observations of De Candolle (Physiol. II. p. 21):

"Independently of the causes determined by the nature of species that modify the time of flowering, there are yet others which appear to depend upon the individuals themselves; in much the same way as one perceives, in the animal kingdom, considerable differences between individuals of the same species who are apparently subject to the same influences. In Adanson's table [footnote] we see that certain lilac shrubs (Syr. vulg.) flowered when the sum of heat degrees amounted to 620, while others required 830 degrees; and further, that certain sainfoin plants (Hedys. onob. L.) flowered after 1100 degrees of warmth, and others only after 1400. Unquestionably these differences frequently arise from variations in the situation of the plants, as for example from a position sheltered from northerly winds or otherwise favourable, from a vein of water flowing past the roots, and so forth; in certain cases, however, such explanations appear wholly inadmissible. Thus it is rare, for instance, that along an avenue planted with horse-chestnut trees, where all the trees appear to occupy the same position, one should fail to remark certain individuals which come into leaf and into flower earlier or later than the rest, year after year. In my time there stood in the botanical garden at Montpellier two horse-chestnut trees close beside one another, and consequently in the most nearly equal conditions possible, yet one of these trees flowered before all the others in the avenue, and the other quite the last. I know a horse-chestnut tree in the neighbourhood of Geneva (near Plainpalais), which every year comes into leaf a full month earlier and flowers by as

much sooner than all the others, without any peculiarity of its situation being discoverable that could explain this earlier development. A similar observation I find recorded in a book which one would not ordinarily cite among scientific works. A witty acquaintance says in his Souvenirs (printed alongside the Memoirs of Constant, vol. VI, p. 222): 'I should reproach myself for the rest of my life if I did not avail myself of this occasion to communicate an observation which I repeat every year when I find myself in Paris at the beginning of spring. Among the horse-chestnut trees of the Tuileries which arch their canopy above the statues of Hippomenes and Atalanta, there is one whose foliage develops before that of all other trees in Paris. I have watched this tree for at least twenty-five years, and never once have I caught it in a negligence. What is more, when one day I spoke of this tree before certain persons, one of them showed me the very same observation written down in the manuscripts of her grandfather; from the indication of the situation it was evident that precisely the same tree was intended as the one I had observed.'"

There also belongs here the following remark by Fritsch in his treatise on the periodic phenomena of the vegetable kingdom, p. 62: "It is not seldom that from two germs of one and the same plant species, which appear alike in outward aspect, two organisms develop, of which the one is weak and frail, and fades away powerless after a short time, while the other develops strong and vigorous and withstands external influences, notwithstanding that both germs developed under the same local and climatic conditions and partook equally of the same care from the hand of nature or of man. Deeply hidden

lie the causes of these phenomena, and their investigation is so intimately bound up with the question of wherein the life of plants consists, that their influence upon the development of plants may long remain unrecognised."

What I have set forth thus far passed through my mind at first only in fleeting impressions, as I stood at the water's edge contemplating the flower that gave the first occasion to all these reflections. And it seemed to me as though I beheld the very soul of the flower rising in a soft mist from the blossom, and the mist grew ever clearer as the meditation took on more definite form, until at last the delicate figure of the soul stood bright, indeed transfigured, above the flower. She wished, it seemed, to ascend for once to the roof of her flowering house, the better to enjoy the sun than within; and there the one who believed herself unseen was surprised by a child of man.

In truth, however, all that I have here set forth seemed to me to contain so much provision, so much demand, and in the end so many signs and symbols of soul and sensation for the plant, that I began to ask myself in earnest where the grounds might lie upon which one could deny them to her; and I was astonished to find them, taken as a whole, so weak. One objection after another presented itself; the habitual conception sought ever again to assert its rights; everything so utterly different in the flower from what it is in man and beast! It was as though troublesome beetles pressed about the flower, and launched an assault upon the strange figure that had appeared above it, threatening to crowd them from their accustomed place, and this figure sometimes shrank

back before them in timidity. Well indeed, Soul, within is truly thy place! Let everything outside buzz and swarm about thy house, ignorant of its inhabitant; within, no one can do thee harm. But so long as I stand here, I will keep thine enemies at bay.

VI. Plant Death and Suffering

VI. Pflanzen-Tod und -Leid.

The thought first weighed heavily upon me: how among all the grasses and flowers of the meadow, all the ears of the field, all the trees of the forest, scarcely one dies a natural death; how all of it falls beneath the sickle, the scythe, the axe; and I asked myself: could nature have endowed so many creatures with sensation only to let them all perish by a cruel death? Are they not, after all, merely here for the adornment and use of other things, rather than to adorn themselves and grow toward their own ends? This same objection first met me when I spoke to a friend of my belief in the plant-soul. No, he said, it would be altogether too dreadful if plants, as ensouled beings, were compelled to suffer all of this and could not even attempt to flee from it.

In the meantime, however, I considered how in those very same lands where no grass or tree any longer dies a natural death, neither does the hare, the deer, the sheep, the ox, nor the horse, nor indeed almost any human being, die a natural death. For who would call it such when a man is cruelly tormented to death by illness? One may attempt to make sense of this circumstance, which accompanies the ascendancy of human culture, as one will; but one cannot draw from it any argument against the capacity for sensation in the creatures who are subject to this fate. Nature has created innumerable creatures with the power for unspeakably manifold pleasure,

yet bound to every capacity for living in pleasure is also the danger of dying in pain.

That the plant cannot even make the attempt to evade an impending harm seems dreadful to us, it is true, but only from our own standpoint. When the soldier, bound fast in rank and file, watches cannonballs cut ever closer, carrying away man after man in their onward passage, this must indeed appear dreadful to him. He feels the ball before it reaches him — perhaps even more keenly than when it truly strikes. But when the reaper moves through the field, the ear of grain knows nothing of his approach, and feels the cut only when it truly falls; not otherwise than the way in which a man too is suddenly struck by many a fate decreed over him by a higher power, without his joy in life having been clouded even for a moment by any foreknowledge of it. This unconcern of the plant may even be regarded as a beautiful aspect of its life, wholly surrendered to the present — a compensation, to be sure, for its want of those higher pleasures that depend upon a wider and farther prospect. Does one suppose that the mouse fares better in spirit when the cat kills it playfully, so that it feels its death a hundred times before it suffers it, than when it is slain by a single blow of the paw? And what is our perpetual flight from the dangers of death but the continual darting away beneath the claws of a great black cat, from which we nonetheless know that we shall ultimately not escape?

In other respects too one is apt to picture the situation of plants as far worse than it truly is. How many countless trees and herbs still die a natural death in the wilderness; how

carefully do we ourselves tend fruit trees and flowers in the garden. And when all the trees of our forests are finally felled, it is after a lifespan far exceeding the average allotted to man. All fields are ultimately mown, but what does grain that has already become straw have left to lose? Before that, it has gained from us both manuring and good husbandry. The grasses of the meadow, in the mowing, are shorn rather like sheep than slaughtered, for the root stock of the grass does not perish but is merely stimulated to fresh, vigorous new growth. In general, when we tear parts from a plant, it has by no means the same significance as tearing parts from ourselves, for plants are constituted differently from us: the cutting or tearing away of individual parts serves only to drive the remaining parts all the more powerfully. If one takes a few blossoms from a plant, the others, and the fruits arising from them, are only the more fully formed. How beneficial pruning can be for the fruitfulness of trees is well known. One need not therefore take to heart too greatly the plucking of a flower or the breaking of a bough. Even if the plant initially suffers somewhat from it, it will be as with the suffering of a human being that serves to drive him beneficially toward greater activity — something which, through its consequences, often does him more good than the suffering itself does him harm. To this must be added that it is very doubtful whether the plant, even granting that it has sensation, feels the cut or the breaking with the same pain as the animal, since entirely different conditions of organisation obtain here. The relations of susceptibility to pain are in general not yet elucidated. Even the animal does not feel a cut in certain parts which are the

very principal bearers of its psychic activities. One may cut away large portions of the brain without producing pain, even as the sensory and other psychic activities suffer thereby. And even these do not suffer, if not too much is removed, since the remaining parts then assume the function of those taken away. So too may one eye be destroyed, and the person still sees excellently with the other. And so too may a single flower be torn from a plant without the plant probably feeling it very considerably, either directly through pain or through any other distress, so long as other equally beautiful flowers remain to it; the vital impulse into these will only increase the more. Were one, however, to deprive it of all its flowers, that would be grievous. But it often goes grievously for man as well, and one will not demand that the plant fare better than man.

The concern that we could no longer walk through greenery, no longer watch a meadow being mown, no longer pluck a flower, without being troubled by the disturbing thought that sentient creatures were thereby caused suffering — this concern will by now appear greatly diminished. We are, moreover, not in such respects nearly as sentimental as we sometimes like to suppose; and were it solely in order to spare ourselves unpleasant feelings that we wished to deny feeling to plants — which is at bottom the entire meaning of the objection — we should in doing so have reckoned upon something that is in truth not there at all.

Let us recall how it does not trouble us in the least to know that on every walk we tread upon perhaps a thousand small creatures; how we eat our roast meat without the

slightest stirring of painful feeling; boil great pots of crayfish; hunt stags, hares, and deer; shoot birds or shut them in cages; impale insects for a collection; skin frogs for experiment; strike at midges in the air with a stick; pour boiling water over ants; shake and stamp upon cockchafers; let flies struggle themselves to death on sticky birdlime. At most, each person merely condemns what he himself is unaccustomed to doing in this regard. From this we may well expect that the thought of the harm we might inflict upon plants in the pursuit of our ends will likewise cause us no great inconvenience. Man knows how to arrange himself in such matters. He reserves his compassion for animals for those cases in which he gains no advantage from killing or tormenting them, or in which that advantage accrues to another rather than to himself. There, this compassion can sometimes become vivid enough. And precisely the same would occur with plants. Whether this is a praiseworthy aspect of human nature need not be examined here; it suffices that it is so, and it may well be as necessarily embedded in the natural concatenation of things as anything else. Yet should man truly learn to treat plants with some greater care where no purpose commands their injury — would that be a disadvantage? I think, rather the opposite.

VII. The Question of Freedom

VII. Die Freiheitsfrage.

The plant possesses no voluntary, free movement — this alone seems to many sufficient proof that it has no soul, and therefore no sensation. For, it is said, both sensation, as it relates to a soul, and voluntary movement, as proceeding from it, are essentially bound together: where the one is absent, the other cannot be present. The plant follows, in all that befalls it, the pure laws of natural necessity. The process may be more complex than that which occurs in the inorganic realm; yet the plant grows with the same necessity — determined by soil, water, air, light, and the internal structural relations of the seed — as the planets pursue their courses. But a soul demands freedom, self-determination.

Perhaps not everyone will frame this objection so sharply. The necessity with which the plant grows and with which the planetary system moves may not strike every mind as entirely equivalent, without his therefore being willing to regard the plant as sufficiently free to consider it also ensouled. Yet the more the objection loses in sharpness, the more it loses in weight. What peculiar kind of freedom, in the end, does one require before a soul may be acknowledged? No matter how one chooses to frame the objection, let us endeavour in what follows to satisfy every possible interpretation of it.

In doing so, we must above all take care not to surrender our entire subject to the confusion, the discord, and the con-

tention in which the whole doctrine of freedom — with the very concept of freedom at its head — remains entangled. The poor, plain, simple soul of the plant might well grow uneasy, and fancy itself quite lost, if all at once so many learned philosophers were to gather around it, and each in his own fashion were to begin examining whether and what it knew or possessed of that freedom which he himself declares to be the sole maker of souls. What should it reply? It comprehends nothing of all these questions. But I take it up and carry it carefully out of the learned circle, out into the open, among the creatures of the forest and the field, with whom it is better acquainted, and there I put to it a few simple questions, which it will doubtless know how to answer.

It ought indeed to be possible to keep everything clear and straightforward, and to give offence neither to the determinists nor to the indeterminists, if only we hold firmly to the single point upon which, given the entire character of our inquiry, everything must ultimately depend: namely, to show that the plant is not worse situated than the animals with respect to any of the actual circumstances that can be decisive in judging of freedom, even if it is situated differently. Whoever then declares the animals to be free will be compelled to declare the plants free as well; whoever does not declare them free — and how many there are who would willingly attribute genuine freedom to the animals — will, to be sure, not attribute it to the plants either, but will then also be unable to demand it of them as a condition of ensoulment, since he does not demand it of the animals on that account. Thus in every case the plants retain as good a claim to a soul

as the animals; let freedom be defined, denied, or conceded in whatever philosophical interest and to whatever degree one pleases — it is enough that the signs ordinarily associated in animals with the words freedom and volition should be found in plants as well, if not in the same, then in equivalent forms. We must, however, take care not to receive the facts already as interpreted; for the task is precisely to draw the interpretation from the facts themselves.

From what, then, do we infer that freedom in animals which we are accustomed to regard as essential to their being ensouled? From this: that we see the animal run hither and thither, fly, cry out, seek its food, without our finding sufficient external occasion for it; something works from within, something we cannot calculate. But in like manner we see a plant drive its buds, branches, and blossoms now here, now there, in this direction or that, without our finding sufficient external occasion for it, or being able to calculate whatever internal causes may be at work. Who can demonstrate to a plant why it drives its leaves and shoots in one manner rather than another? Freedom manifests itself here, it is true, in an altogether different sphere of activities than in the animal; yet even within the animal kingdom there is already great latitude in this respect. That in plants more depends on compulsion by external causes than in animals cannot be maintained, since we observe different plants under identical external circumstances behaving differently just as readily as different animals do. No plant has ever driven its branches, leaves, and flowers in quite the same manner as another, even when placed in entirely similar situations. Each plant, admittedly,

remains within certain general rules, more or less determinate, that are bound up with its own nature; but so too does every animal — it can only run as its legs have grown, only feed as its beak has been fashioned. The plant, it is true, is co-determined in the movements of its growing, bending, and folding by external stimuli — light, air, moisture, soil; but so likewise is every animal. How greatly are its movements co-determined by the attractive and repulsive force of external stimuli; only not by these alone — just as not in the plant. One might conceivably suppose, in the case of the plant, that the action of external stimuli, taken together with the conditions internally residing in its structure and constitution, necessarily and entirely determined its behaviour under all circumstances; but precisely the same may be supposed of the animal. Does it perhaps display fewer complex internal conditions than the plant — conditions whose addition to the external ones might conceivably suffice to explain whatever cannot be made dependent on the external alone? On the contrary, it has yet more; which also unquestionably accounts for the possibility of still more manifold and intricate activities in its case. If one wishes, then, to deny freedom to the plant by this path, one certainly may do so, and I myself am fully of the opinion that there is no obstacle to doing so; but it is precisely the same path that leads to denying it to the animal as well. And since the animal nonetheless feels sensation and impulse, one will be able to grant the same to the plant with equal justification.

Freedom in the highest, in the moral sense, no one will unquestionably wish to attribute either to animals or to

plants; but whether, outside of this freedom, everything in the world is not necessarily conditioned, may all the more readily be asked, since many thinkers know how to conceive even moral freedom itself as inner necessity. What is certain, at all events, is that freedom and volition in the ordinary, lower sense are not matters to be treated with such anxious concern that one could not, without danger of coming into conflict with higher interests, conceive their appearance as dissolved in an underlying necessity. We attribute freedom even to a madman who rushes forward in blind impulse, inasmuch as he is not in chains, yet we grant that at bottom something compelling from within drives him, and we do not on that account deny him feeling and sensation.

I hold that what one must essentially demand, in matters of freedom, of any creature in order to attribute to it a soul, is simply this: that it feel the impulse toward certain activities as its own. This suffices. Whether that feeling of impulse arose of necessity or not is a question one may certainly go on to investigate, but whatever the answer may prove to be, no argument against the existence of a soul can be drawn from it. Only a twofold view of the nature of the soul that believes itself free can arise therefrom. The hungry fox seizes the hen; that he does so is perhaps entirely necessitated by his constitution and by the presence of the hen, or perhaps not, for I decide nothing here, though for my own part I incline to the former opinion — yet this is of no consequence here. That he feels the urge to seize the hen as his own, in a sense analogous to that in which a man who yields to a sensual appetite feels that appetite as his own, makes his actions voluntary,

free in the lower, common sense, which is all that will be required of an ensouled being, and which is also sufficient. Even if the plant drives its leaves and branches, of necessity and without any higher freedom, in whatever direction it drives them, yet so long as it feels the impulse to do so equally as its own, feels the compelling force within itself — as an animal does when it stretches its claws in the act of catching, or sets its feet when running — so too does the plant drive its leaves and branches in the same sense freely, voluntarily; and where is the sign that this is less the case with the plant? On the contrary, setting aside the form of the driving, everything is analogous to what obtains in the animal. Does not indeed the very commonality of the word impulse, as applied to us, to the animals, and to the plants, point toward something common therein? In impulse, something wishes to issue forth from us, or we ourselves wish to issue forth beyond our present condition; of this the soul has the feeling. Whether the impulse carries a being entirely away — one that is not rooted in place and must move to attain its end, as is the case with us — or whether, as with the plant, which being rooted cannot be wholly carried away, it drives the plant to extend itself beyond itself in every direction where something is to be gained, changes nothing in the essential nature of impulse; and the feeling of it may be equally strong and vivid in both cases. One has immediately before one the contrast to this, if one imagines that the plant, instead of extending itself in the direction toward which a stimulus drives it or an inner vital power presses it through the play of its own forces, were dragged or bent thither by some external force. In that case,

assuredly, no feeling of one's own impulse would be present within it. It is the same distinction as whether our arm is extended by the play of forces properly our own, or another person extends it; the former case is bound up with the feeling of one's own impetus to do so, the latter is not. Why should it be otherwise with the plant? Moreover, both cases may possibly be subject to equal necessity; in the one case only the constraining moment acts from within, and in the other from without.

These reflections cast nothing in an artificial light, but rather bring the true state of affairs clearly to light for the first time — a state that in the ordinary mode of consideration is obscured by the circularity of our already regarding plants, in contrast to animals, as devoid of soul, and consequently conceiving their driving from the outset from the standpoint of a more soulless necessity than that of animals. Against this, it becomes apparent upon the setting aside of all preconceived opinion that necessity in general is not in the least more demonstrated in the case of plants than in that of animals; that however probable it may seem in both cases, this probability applies equally to the animal and to the plant; and that even were it fully demonstrated, nothing would thereby be proved against a soul-impulse, since such an impulse is not in any way bound to the categories of necessary or non-necessary origination. Ultimately, every being believes itself to act freely when it acts according to its pleasure, for this is connected with the feeling of impulse toward a thing. But that it takes pleasure in this thing or that depends itself upon its physiological and psychological constitution.

Most directly and decisively does the character of acting from free impulse, or according to pleasure, manifest itself in the animal in this: that it seeks, through an expenditure of inner forces, to attain the conditions of life favourable to it and to flee the unfavourable ones. Running after food, it feels what causes it to run thither. Why should we be less inclined to believe that the plant, when it grows toward food, feels what causes it to grow thither? It is drawn toward that food by outward attraction as little as is the animal. The animal is driven by hunger, by the pleasure of savour; why should the plant be less hungry when nourishment is lacking, or less taste whether it finds agreeable or disagreeable nourishment? The exertions to find the right nourishment are in any case no less in the plant than in the animal, and very analogous; only that the animal shifts itself entirely toward the nourishment, while the plant shifts parts of itself toward the nourishment; and that the plant is not guided in its seeking by eyes and ears, but by sensitive filaments that it sends out in every direction.

Indeed, how far the plant often extends its roots; how it creeps about with them in order to find fertile soil. Where it finds such soil, there it establishes its dwelling, so to speak, and forsakes the barren places; indeed it often seems to scent the good earth at great distances and to find its way thither through narrow crevices in walls or rocks, while the rooting develops but little in the direction of infertile ground. There are remarkable examples of this. There are even cases in which the entire plant has thereby moved from its place and has, so to speak, fallen into the habits of an animal. These

cases prove no more than those in which the plant remains stationary; yet they prove the same thing nonetheless, and very plainly.

"Among the ruins of New Abbey in Gallowayshire there is a species of maple (Acer pseudoplatanus); it once overtopped the wall, but, pressed by want of room or of nourishment, it sent out a strong root from the height of the wall, which took hold in the ground below and was converted into a trunk; and having freed the remaining roots from the top of the wall, the whole tree became detached from the wall and independent. The tree departed in this manner from its original position; Lord Kames takes notice of the phenomenon, and the fact is undoubtedly correct. — A gooseberry bush that stood in a corner of a garden in a poor, sandy soil sent out a branch in the direction of the better soil, which put down its roots along the way thither; the original bush died off, and the plant advanced toward the better soil. — At Lake Como, near the Villa Pliniana, hanging roots may also be observed, which have crept down the surface of the rock and become trunks." (Murray in Fror. Not. XXXVIII. p. 278.)

Assuredly, the plant can no more truly scent the good earth from afar than an animal can scent anything from afar without something reaching it from that distance, be it only for sight or smell; otherwise the animal must run about feeling its way until it finds what suits it, and then it stays with it. So too it will be with the plant; perhaps it is a vapour of mould that lures the plant toward fertile ground; perhaps, and far more probably, it sends out its root fibres in all directions until they have struck good soil, whereupon these in-

crease in strength and branch out, while the others wither away, and so it may appear as though the plant had scented the good earth from afar. The matter has not yet been fully resolved. But by whatever path the plant finds its nourishment, it knows how to find it; and among animals likewise there are very diverse paths thereto.

One may of course say, when one observes a plant sending its roots long and slender through barren soil in search of nourishment, that the physical stimulus of that infertile earth upon the plant, peculiarly constituted as it is for a purposeful counter-reaction, suffices to explain this outcome by purely physical means; that there is no need to seek further cause and impulse in a soul. But this is merely another form of the objection concerning the absence of freedom, and the same answer applies here. Certainly one may say so, only that one can say precisely the same of men and animals if one chooses to interpret the phenomena in that manner, and can no more prove it in the case of plants, when proof is once demanded, than in their case; in short, the state of the matter remains identically the same in both. In my view, given a perspective which does not otherwise appear so objectionable — that everything spiritual here below has its bodily expression immediately united with it — the possibility of explaining something from purely physical or corporeal mediation ought not in any way to stand opposed to the possibility of explanation from spiritual grounds; for the spiritual ground itself demands its expression in the corporeal. Whoever takes the position of wishing everywhere to pursue only the expression in the corporeal, as is the standpoint of the natural scientist,

may certainly do so; yet in doing so, he must not wish to deny the soul which, in its corporeal expression for others, also becomes aware of itself. Even my own act of will, to reach for a piece of bread, must be accompanied by a bodily process in the head which stimulates the arm to movement; we know indeed that in the act of will this is set in motion from the brain. Now it might occur to a physiologist to wish to deny the soul's act of will, because from his own standpoint he could make the movement of the arm dependent upon that physical process in which the will expresses itself immediately in the head, and which he might regard as further conditioned, working backwards, by the physical impression of the bread upon the senses, the physical state of hunger in the body, and the particular condition of the brain that preceded the act of will. As a physiologist he may perhaps be entirely right to conceive it thus; but the human being has yet another side than that which presents itself to the physiologist, a side which the latter must indeed leave unseen — why then not the plant equally so? We may certainly push everything physiologically onto its inner bodily processes, but we ought not to do so merely for that reason, when these processes reveal themselves as purposive for the plant in the same manner as they do for man. The material grounds which we may for the sake of physiological coherence always suppose in such cases ought to count for us only as the expression or vehicle of psychical grounds, serving a psychical connection which is itself borne by that physiological one.

But of course there lies a fundamental error in our entire present mode of contemplating nature — the belief that the

spiritual can only ever walk before or behind the corporeal, but never step forward immediately within its very shoes; and in that we are forever shifting the one into the context of the other, we lose the coherence that each possesses within itself, as well as the coherence of both together within the whole.

But I know well that I shall neither alter nor improve this here. Whatever one may think of the matter, it suffices to hold fast always to the factual and for us decisive point: that all presupposed possibility of explaining everything in the plant by purely physiological means can, so long as the same presupposition of that possibility holds in the case of animals for entirely equivalent reasons, prove nothing against the working of a soul within it; and conversely, the validity of this presupposition in the case of plants is precisely as hypothetical as in the case of animals.

The communication of some particular examples of how plants seek, through the play of inner driving forces, to place themselves under the proper conditions of life, will serve to illuminate the foregoing still further.

Professor Schwägrichen told me how he had once received word from the Mansfeld district that an enormous new cryptogam with a scaly stem had been discovered in the mines there, having grown upward underground to a length of perhaps thirty ells, yet without managing to reach the full light of day. What was it upon closer examination? The underground stem of a plant that under ordinary circumstances stands but a few inches high — a Lathraea squamaria — a piece of which had unquestionably found its way into that great depth by chance. Now the stem strove toward the light

and grew and grew ever onwards, because it could not attain it. Is this not like a person whose every striving is directed toward a certain goal, who, when unable to reach it, continues to labour toward it indefinitely until at last he either attains it or exhausts himself? To be sure, the plant will not have had a clear image before it of what it desired; what did it know of light? But it will have felt what it did not want — namely, to remain underground, where it could produce neither leaves nor blossoms. To escape from this condition will have driven it. But why then grow upward? How did it know that this might lift it out of the earth in which it still remained for the time being? Yet how does the caterpillar know that it must spin itself in, in order to escape its present caterpillar state, which may no longer suit it? We only do not know how it knows. But if caterpillars and spiders can feel the drive to draw threads from themselves in order to attain the ends set for them by nature, why should we not trust in an equal feeling for the Lathraea when she draws herself upward, in a circumstance that falls under the same point of view?

Mustel placed a pot of jasmine (Jasminum azoricum) behind a board which had several holes in it, each two inches square and at six inches' distance from one another. The stem first grew through the nearest hole toward the light. Mustel turned the board and the pot about, so that the branch which had grown through was again turned away from the light; whereupon the stem grew through the second hole toward the light once more. Mustel repeated the procedure, and so the stem grew, winding itself back and forth from one side of

the board to the other, gradually through all the holes in succession. (Mustel, Traité de la vég. II. 101.)

Confine an animal, confine a person; and assuredly he will escape through the first or most conveniently situated opening you have left; confine him again and he will escape again through the most conveniently situated opening — as certainly as the plant does it here, unless chains should bind him. That the plant does it no less surely, and indeed perhaps more surely, does this speak against or in favour of its feeling the need for light and air as surely as we feel the need for freedom? Were it to remain once behind the board, I should be far more inclined to believe it indifferent to the light; but now that its feeling compels it, should that feeling be on that account any the less feeling?

Glocker observed how a Stachys recta standing close in the undergrowth at the edge of a wood, after driving its stem but a few inches perpendicularly upward, suddenly deflected at almost a right angle and turned in a horizontal direction toward the spot where the light fell with greater strength through a small opening in the thicket; and in this horizontal direction it continued to grow until it had reached the margin of the undergrowth, where its outermost part, which now enjoyed the full benefit of the light, resumed the vertical upward direction once more. (Glocker, Versuch über die Einwirkung des Lichts auf die Gewächse, p. 25.)

Warren observed a potato shoot in a cellar which received only a little light through a small opening, drawing itself twenty feet across the floor toward that aperture. (Mem. of the American Academy of Arts and Sciences, Vol. II. P. I.)

That the plant in these experiments pursues the light and not the air is demonstrated in particular by the observation of Tessier, that when two openings are made in a cellar, one of which is open and admits air but not light, while the other is fitted with a glass window admitting light, the plants kept in that cellar continually draw themselves toward the latter opening, not toward the former. (Lamarck et Decand. Flore franc. T. I. 198.)

We call it instinct — that which teaches every animal to arrange its movements so that its proper conditions of life work to its benefit, in what manner it teaches we do not know. What do we encounter in those strivings of plants other than all the outward appearances of instinct? Every animal acts differently in consequence of its instincts, because different things serve it; every plant does likewise. I shall adduce a few further examples.

All plants that grow in the earth drive their roots straight downward; the mistletoe is not bound by this necessity. What purpose would it serve? It roots upon other trees — and not merely upon the upper side, but just as readily upon the lateral surfaces or the underside of branches, in which case it may even be necessary for it to drive its root upward. And so it does; sending its little rootlet perpendicularly against the surface of the branch, in whatever direction that surface may be inclined. Indeed, if a mistletoe seed is suspended by a thread at the distance of a line to one side of a branch, the small root perceives from even this remote distance where the branch lies, and directs itself accordingly — to the right or to the left, depending on which side the branch is situated. It is true that

in doing so it also grows perpendicularly against a wall of stone or iron, in which it can find no nourishment; and if mistletoe seeds are sown over the surface of an iron sphere, they all strive with their rootlets toward its centre, as though they expected to find what they need in that direction. Here their instinct deceives them. But is this any different from the hen that wishes to hatch eggs of marble, or the quail that follows the bird-call rather than the cry of its mate?

Instinct is everywhere bound to allow itself to be guided by physical influences, and thus, under certain circumstances, to be deceived by them as well. Undoubtedly the little rootlet of the mistletoe is able to detect the branch or wall from a distance only because the air and moisture and light and warmth reach it differently from that side than from the other; hence, at too great a distance, it can no longer find them. In general, and on the average of circumstances, instinct is guided correctly by these influences, because its constitution is calculated for them; yet, as with all universally purposeful arrangements, individual cases may arise in which the normal circumstances are reversed and what is ordinarily serviceable becomes useless. If we find this to be the case with the instincts of animals, we cannot very well require it to be otherwise with those of plants.

The mosses, too, a plant genus of an altogether different character from the mistletoe, drive their rootlets in any direction whatsoever, always perpendicularly against the surface on which they root, since they likewise grow upon trunks and branches; but the remaining plants are so resolute in directing their roots downward that, when the vessel in which they

have been sown is repeatedly inverted, they redirect the growth of their roots an equal number of times. In principle, plants in general behave toward the great terrestrial sphere in very much the same way as mistletoe seeds in the experiment described above behave toward the small sphere upon which they are sown, driving their roots from all parts of the earth toward its centre. One thus perceives that nature is indifferent to the size of the sphere; it does not adjust itself according to size, but has for every sphere its own beings who know how to comport themselves purposefully in relation to it.

From what has been said above, one may readily perceive how unfounded is the objection which Autenrieth advances in the following manner against the soul of plants: "In part," he says, "the plant itself also exhibits visible movements in individual organs in response to external stimulation, but only to such stimulation as has already acted upon it; it cannot, as can the ensouled animal, seek out those stimuli which are not yet present. Toward a wet sponge a creeping plant extends its trailing tendrils, but only after the water vapours have already acted upon it; a thirsty animal seeks water even where none is."

But the Lathraea did seek out the light before it had acted upon it, and the rootlet of the mistletoe seeks the surface in which it intends to root before it has yet reached that surface. That they are determined to do so by their inner nature and constitution, and co-determined by external influences, is entirely analogous to what we observe in animals.

One may perhaps raise the objection that much in us, too, proceeds purposefully — the circulation of the blood, the

movements of the digestive organs, the metabolism and nutrition — without our perceiving anything of it; and that therefore the driving of roots and other processes in plants might likewise proceed toward their ends without any sensation of the impulse. So be it. But the movements of digestion, the circulation of the blood, and so forth, if they are not themselves felt, serve no purpose for us other than to render and maintain us capable of other sensations; indeed, one could not properly speak of a purpose of these processes for us at all, if they served merely to sustain us as arrangements wholly devoid of sensation. Thus, even granting that no particular sensation of impulse were attached to the driving of roots, we should still be obliged to assume that this process serves the purpose of sustaining in plants beings otherwise capable of sensation. It is possible that this is indeed the case — that all activity of the plant beneath the earth provides, in an analogous manner, only what one might call a soul-darkened foundation for the clear sensations that are bound up with the activity of the plant above the earth, just as we posit in ourselves such a dark region standing over against a brighter one; yet we ought not then to deny those brighter sensations themselves, lest we accuse nature of having created purposively acting beings for whom no purposes exist.

But it is not even strictly accurate to say that we perceive nothing of our circulatory and digestive movements and the like; it is merely that they do not ordinarily make themselves felt in clearly distinct sensations. The general normal feeling of vitality and vigour, however, shows itself to be essentially bound to the normal course of these processes. Let these pro-

cesses suddenly come to a standstill, and the feeling of life vanishes just as suddenly — not merely in the general sense, but in every particular sensation as well; for this feeling of life must, as its very foundation, enter into every individual sensation. And yet, although no determinate sensations commonly seem bound to the ordinary course of these processes, such sensations arise immediately the moment anything departs from the customary path. We then feel heat, cold, oppression, anxiety, pain, cramp, hunger, thirst — the last even in its regular recurrence — according to whatever is occurring in our viscera and in our circulatory system. Thus, even supposing that the plant felt nothing particular when its roots continuously find the nourishment for which the plant is, on the average, constituted, this would not preclude that, when any deficiency in the fulfilment of these conditions arises, it should immediately perceive this as a felt need.

Finally, the driving of roots cannot at all be placed on the same footing as the movements of our digestive organs and our blood, inasmuch as the latter are processes occurring inwardly with respect to materials already taken up within us, whereas the former proceeds outward into the external world in pursuit of life conditions yet to be obtained. All such activities in us, however, are governed by the dominion of distinctly felt impulses.

Stated with every possible caution, it seems to me that the question can only be whether the root-impulse of plants, under ordinary circumstances, participates in the sensation of the plant in a more general or more particular manner; and I shall not presume to decide this with certainty. Yet everything

speaks in favour of its participation in sensation — and assuredly the more so, the more the plant must first actively seek its normal conditions of life; for it is precisely in such cases that we see plants making particular efforts to discover those conditions.

With respect to the activity of plants above the earth, the following section will enter into further discussions that bear upon the foregoing.

VIII. Growth, Twining, Bending, Turning of Plants

VIII. Wachstum, Winden, Biegen, Drehen der Pflanzen.

The reflections of the preceding section led us to connect the growth and striving of plants in root, stem, branches, leaves, and so forth — insofar as this presents itself as a means of satisfying their needs — with an activity of their soul.

Against this, an objection arises that appears weighty.

We ourselves have no determinate sensation of our own growth, nor do we feel any impulse to grow in one direction or another; on the contrary, our process of growth lies altogether apart from our consciousness. How, then, should the very same process in plants suddenly acquire a relation to consciousness?

I reply: our growth and that of plants are in general two things not properly comparable with one another, sharing the word but — as will shortly become still more apparent — sharing precisely none of those features which must be decisive for the question of connecting soul-phenomena to growth. And even in ourselves and in animals, the process of growth cannot be regarded as wholly uninvolved in the life of the soul, since the processes of nutrition and circulation, upon which it depends, are not uninvolved therein (cf. the preceding section). On the contrary, a sudden arrest of normal growth would certainly be felt by us as well, in the form of an altered and probably depressed vital mood. It is only

that what the process of growth contributes to the normal feeling of life does not separate itself out as a distinct sensation. If, however, as we have seen, the processes of nutrition and circulation do, under particular modifications, give rise to specific sensations — hunger, thirst, cold, heat, and the like — there is no reason to consider the growth-process connected with these as in itself less capable of the same. It is simply that in animals it is less disposed toward such modifications; but in plants all the more so, as will presently be shown. Thus nothing altogether new or foreign is being attached to the growth-process of plants; rather, to the especially prominent and peculiarly constituted development which this process actually attains in plants, there is attached a correspondingly prominent and peculiarly constituted development of the soul's contribution, which it already furnishes in any case.

Let us recall that plants are not meant to repeat animals, but to complement them. Only the general conditions of the life of the soul will always be preserved alike in both; in particulars one must not demand correspondence. Plants seek through free growth to attain what animals seek through free locomotion, and thus in plants, naturally, analogous emotional dispositions and impulses of the soul are bound to the movements of growth as are bound in animals to movements of place. Purpose determines means in nature, and to the different character of the means there attaches itself a different feeling with respect to the attainment of the end.

Let us now pass through the principal differences between the growth of animals and plants, and we shall find that we

are here dealing with things far more diverse than the use of the same word for both might lead one to suppose; and we shall find at the same time that the differences lie genuinely in the direction we have required.

1) In the growth of animals, nothing is left free with respect to the principal form. A dog has a tail, four legs, two eyes, a tongue — all of these always in the same place, in the same number; only finer proportions vary. If, therefore, the animal feels no impulse to grow in this direction or that, it is because it has none. An apple tree, by contrast, forks now into two, now into more principal branches, which may set themselves at the most varied angles and at the most varied heights; each branch again puts forth, so to speak, at will its boughs, its twigs, its leaves in one way or another, without allowing number, order, or direction to be prescribed by any fixed rule. This is precisely what is left free for an impulse that is still to be drawn hither and thither by external occasions, by the stimuli of sensation; whereas in animals it is instead the possibility of diverse change of place that is left free. The animal, through its growth, fills out only, so to speak, a prescribed form, which must then serve it for the further shaping of its life; in the plant, the shaping of life itself coincides with the shaping of growth, and for this very reason growth cannot confine itself within so rigidly prescribed a form. It still receives direction from the supervening conditions in relation to which the plant must comport itself. And yet not from these alone. For an internally prevailing principle of unity maintains — as we set forth earlier — for each plant, despite all the freedom of its growth, a fundamental character

that is even outwardly visible, held inviolably fast. Yet this is precisely the character of the soul: that amid all the diversity and freedom of its expressions, it does not abandon the guiding thread that governs the whole.

2) In accordance with the foregoing, the growth of animals adjusts itself little to the season of the year, the time of day, the weather, and other external circumstances; it grows ever onward in its prescribed manner; but it acts differently according to season, time of day, weather, and external circumstances. The plant, on the other hand, grows differently according to season, time of day, weather, and other external conditions. Thus the growing of the plant stands in the same relation as the acting of the animal. Winter is its time of sleep, during which it does not grow at all; it grows more rapidly by day than by night; more rapidly under the right alternation of warmth and moisture than when it is always too hot or too moist. And not merely faster or slower, but differently in every different state of weather; differently in every different aspect to the sun; differently in every different situation. Individuality throughout retains its prerogative, insofar as different species of plants, and even different individuals of the same species, and even different parts of the same individual, always grow in a characteristically distinct manner even under identical external conditions.

Professor E. Meyer of Königsberg has established that a rapidly growing stem grows during the day almost twice as fast as during the night. An Amaryllis Josephinae extended its straight, leafless flower-stalk within 12 days by 21 Rhenish inches. The increase in length was measured precisely each

time at six in the morning, at noon, and at six in the evening, and amounted during the 12 forenoons together to 6" 9"', during the 12 afternoons to 7", thus during the day as a whole to 13" 9"', but during the 12 nights to only 7" 3"'. Quite similar results were obtained by Dr. Palm in his observations of the hop and the bean (Fror. Not. XLI. p. 218). Cf. also the experiments of E. Meyer on barley and wheat plants in Linnaea IV. p. 98; of Mulder on the leaf of Urania speciosa and Cactus grandiflorus in Treviranus' Physiol. II. 145; and of Gräfe on the flower-stalk of Littaea geminiflora in Flora, I. 1843. p. 35.

"Among dry rocks, upon meagre, sun-exposed limestone crags, Carlina appears entirely acaulis: let it gain even a slightly looser soil, and it immediately raises itself; in good garden loam one no longer recognises it, it has acquired a tall stem and is then called Carlina acaulis caulescens." (Goethe, Metamorphosis of Plants, Collected Works XXXVI. p. 126.) — The dahlia is in its wild state a very inconspicuous plant, in which one would scarcely recognise the stately ornamental plant of our gardens. — The influence of garden cultivation upon the growth of plants is in any case sufficiently well known.

Eckermann, in his Conversations (third volume, p. 101), relates to Goethe certain experiments he had undertaken in order to discover the most suitable wood for the making of a bow, in the course of which the following remarks occur, of interest to us as well. "On this occasion I learned (from a wheelwright) that there is a great difference between one ash-tree and another, and that with all kinds of wood very much depends upon the place and soil in which they have grown. I

learned that the timber of the Ettersberg is of less value as useful wood; that, on the other hand, the timber from the neighbourhood of Nohra possesses a particular firmness, on account of which the Weimar carters have a very special confidence in repairs made at Nohra. In the course of my further investigations I made the discovery that all timber grown on the winter side of a slope is found to be harder and of straighter grain than that grown on the summer side. This too is readily comprehensible. For a young trunk growing up on the shaded northern side of a slope has only to seek light and sun from above, and being ever athirst for sunshine, it strives perpetually upward, drawing the grain with it in a straight direction. A shady situation is likewise favourable to the formation of a finer grain, as is very strikingly visible in those trees which stood so freely that their southern side was exposed to the sun for life, whilst their northern side remained perpetually in shadow. When such a trunk lies sawn into sections before us, one observes that the point of the heart is by no means situated at the centre, but is considerably displaced toward one side. And this displacement of the midpoint arises from the circumstance that the annual rings on the southern side, owing to the continual action of the sun, have developed considerably more strongly and are therefore broader than the annual rings of the shaded northern side. Joiners and wheelwrights, when their concern is a firm and fine-grained wood, therefore prefer the more finely developed northern side of a trunk, which they call the winter side, and in which they place a particular confidence." — One should here bear in mind that it is not what has grown, but

the growing itself, while it takes place, that is to be regarded as a vital expression of the plant. The tree leaves its path of life behind it, lignified; yet it is not the wood, but the activity which caused the wood to pursue this path, that demands our attention. According as the tree grew differently, it will have experienced a different impulse.

In the same Conversations, Vol. III, p. 146, Goethe himself says on another occasion: "When the oak grows up in the thicket of the forest, surrounded by considerable neighbouring trunks, its tendency will always be directed upward, ever toward the free air and light. To the sides it will put forth only a few weak branches, and even these, in the course of the century, will wither and fall away again. But when at last it has succeeded in feeling its crown free in the open air above, it will settle itself, and then begin to spread sideways and to form a canopy. Yet by this stage it is already past its middle age; its many years of striving upward have consumed its freshest energies, and its endeavour now to assert itself powerfully in breadth will no longer meet with proper success. Tall, strong, and slender-stemmed it will stand at the completion of its growth, yet without such a proportion between trunk and crown as to be truly beautiful. — When, on the other hand, the oak grows in moist and swampy places, and the soil is too rich, then, given sufficient room, it will early put forth many branches and twigs in all directions; yet the opposing, retarding influences will be lacking, the gnarled, wilful, jagged character will not develop, and, seen from some distance, the tree will acquire a weak, linden-like aspect, and will not be beautiful, at least not as an oak. — When, finally,

it grows on hilly slopes, on poor, stony ground, it will indeed appear excessively jagged and gnarled, but it will lack free development, it will early languish and stagnate in its growth, and will never attain that of which one might say: there dwells within it something capable of filling us with astonishment. — A sandy soil, or one mixed with sand, where it is permitted to drive powerful roots in all directions, seems most favourable to it. And then it requires a situation which affords it sufficient room to receive all the influences of light and sun and rain and wind from every side. Reared in comfortable shelter from wind and weather, nothing will come of it; but a hundred years of struggle with the elements makes it strong and mighty, so that at the completion of its growth its presence inspires us with astonishment and admiration."

Hartingh says, following experiments on the hop plant: "The growth of the individual stems of one and the same plant, although exposed to perfectly equal external influences, is not only unequal, but one also perceives no regular behaviour in their daily elongation. — At the commencement of growth there takes place a daily increasing acceleration of growing which is independent of external influences." (Wiegmann's Archive, 1844, Vol. II, p. 41.)

* * *

An animal soon ceases to grow, its form being more extended than altered in the process; instead of continuing to grow, it eventually runs off. A plant grows continuously throughout its life; for it, to cease growing and to reshape itself in growing is to cease to live; instead of stretching out hands and feet ever anew to create something new or to procure something

new for itself, it stretches out ever new branches and leaves to the same end; instead of transforming other things, it perpetually transforms itself. — Let us consider an ear of corn, how in early spring it grows unceasingly upward, and when it slackens in this, its grains begin to grow; when nothing more will grow at all, it withers; it becomes straw. — Let us consider an arum (Calla), how ever one leaf after another grows forth from the centre; it is an inexhaustible funnel from which the leaves well up; it continues thus until the last moment. — Let us consider a tree, how each year it sets a new annual ring, and from this drives new branches, new buds, while the old leaves fall; not to have them but to drive them forth seems to be its purpose in life. — Indeed, let us consider any plant that puts forth shoots with the spring; it grows throughout the whole summer, upward, sideways, above the earth, below the earth; always making something new of itself.

Some plants achieve an immense degree of this over a long life, just as some persons, over a long life, are capable of producing great and numerous works. Only the plant appears far more itself as the work or the nexus of works which it has shaped than does the human being; though even he, at bottom, in all his outward activity more or less remakes himself as well; and likewise the plant, in shaping itself, works into the outer world in many altering ways that are accounted for within its purposes. As everywhere in nature, there are here no absolute distinctions.

Who does not know the examples of immensely thick trees that have grown for millennia, trees which would in-

deed boast of having stood since the creation of the world, and have not grown weary of marking each year by an annual ring.

"The famous Castagna dei cento cavalli (Castanea vesca) on Etna must be some thousand years old. The baobab trees (Adansonia digitata) on the Cape Verde Islands are estimated, according to their girth and the number of annual rings on certain branches, to be four thousand years old and more. The giant cypress (Cupressus disticha) at Santa Maria del Tule, two hours east of Oaxaca in Mexico, has a circumference of one hundred and twenty-four Spanish feet, thus forty feet in diameter; reckoning each annual ring at two lines, the tree is nearly fifteen hundred years old; it is historically certain that it is older than the conquest of Mexico by the Spaniards. The age of the great dragon tree (Dracaena Draco) of Orotava on Tenerife is determined at more than five thousand years, and it would thus, by the ordinary computation of Jewish mythology, be almost a witness to the story of creation." (Schleiden, Grundzüge, Vol. II, p. 629.)

Some plants grow slowly, others swiftly, just as among animals there are the sluggish and the fleet.

"An alga, the everlasting bladder thread, has been found by sailors to be fifteen hundred feet long, and Mr. Fanning, the owner and curator of the botanic garden at Caracas, states that some years ago he raised a species of Convolvulus within six months to no less than five thousand feet, which would give, on average, twenty-four feet for one day and one night." (Murray in Froriep's Notizen, Vol. XXXVIII, p. 250.)

A well-known experiment consists in stripping the anthers from a flowering rye-ear and placing the upper part of the stalk in water, whereupon within a few minutes other anthers emerge and the filaments extend by as much as a quarter of an inch.

"According to an approximate calculation, some twenty thousand new cells are formed every minute in a very rapidly growing fungus, the giant puffball (Bovista gigantea)." (Schleiden, Die Pflanze, p. 43.)

4)

In human beings and animals, the summit of life falls only in the period after growth is complete and all organs are fully developed; in plants, the summit of life coincides with the development of a new organ — the flower itself — and the whole process of growth undergoes remarkable changes at that moment. What could better demonstrate that in the plant, unlike in the animal, the activity of growth and the development of organs are not merely means of establishing the conditions for the purpose of life, but are themselves intended to be the means of realising that purpose?

Certain plants — though not all — display a strikingly heightened impulse toward growth around the time of flowering. The so-called century plant (Agave Americana), for example, passes three or four years in southern Europe, and in the hothouses of temperate regions often fifty or sixty years, before it begins to shoot upward and to bloom; but then it suddenly drives forth, within a few months, a flower stalk that attains a length of fifteen and eighteen feet. After flowering, the parent plant dies, and only lateral shoots remain.

Thus all vital energy is consumed in the driving and the blooming. If one waters the soil in which the plant is rooted while it is putting forth its flower stalk, the plant draws the water so powerfully into itself that observers report having seen it disappear with an audible hiss. But if the plant does not drive a flower stalk, whatever water has been poured in excess of what the soil in the vessel can absorb stands upon the surface undrained. It is well known that plants in general require more water during the period of flowering than at other times; indeed, many which must otherwise be kept quite dry, such as the cactus, need to be adequately watered around the time of their blooming. The Agave foetida, or Fourcroya gigantea, had been cultivated in the Paris garden for nearly a century, and had during all that time shown only a slow and moderate development, when all at once, in the summer of 1793, which was a tolerably warm one, it began to shoot rapidly upward — by twenty-two and a quarter feet in seventy-seven days, an average of three and a quarter inches per day, and on certain individual days by nearly one foot. (Decand. Physiol. II, p. 34.)

5)

In the animal, the organs, once fully developed, remain in the most vigorous state of metabolic exchange, being continually recomposed of new substances while retaining the same form — a process that holds even for the bones. The functions proceed most powerfully within the completely formed organs. In plants, by contrast, the organs recede, in proportion as they are formed, ever further from metabolic activity and from living function; the newly introduced substances are

employed solely to form new organs; the older organs remain as residues, so to speak, of earlier vital activity, to permit new ones to be attached about or upon them — or else they fall away. Thus the woody body of trees withdraws, as fast as it is formed, more and more from any living commerce with the outer world; a tree may become hollow within and yet continue to grow vigorously on the outside; leaves manifest all vital phenomena more feebly the older they become, and at last fall away to make room for new ones. The organs of the animal grow old and wither, it is true — but only as the whole animal grows old, withers, and withers for ever. Not so in the plant. This distinction, like all those here under consideration, is only relative; for assuredly no organ of the living plant entirely withdraws from living activity; yet it is, taken as a whole, characteristic.

Duhamel divided, by means of fine silver wires, a certain space on the stem of a horse-chestnut seedling of one and a half inches in height into ten equal parts. By the following autumn all these divisions had moved apart from one another, and the more so the nearer they had been placed to the upper end. In the second year, when the new shoot had attained a length of four to five lines, it was marked in the same manner, with the same result, while the marks upon the shoot of the first year showed no further elongation. That part had, so to speak, finished, settled. Similar observations were made by Hales on the vine. Duhamel further drove a stake into the ground beside a young tree, furnished with a pointer whose tip corresponded to a mark made on the bark of the sapling. The pointer continued ever afterwards to correspond precise-

ly to the mark, although the tree had in the meantime grown considerably in height. Parts once fully lignified neither expand further in thickness nor in length. Growth invariably affects only the younger and fresher parts. Duhamel drew silver threads through roots that were vegetating in pure water, or marked them externally with coloured varnish, so that he might readily recognise the marks again. The general result was that all marks had retained their distance from the collar of the root, however greatly the root might have elongated — a proof that the root continues to grow only at the tip; although, as other experiments showed, this is not accomplished solely by external addition of cells at the tip, but rather through elongation occurring within a small stretch at the apex. Further matters of interest concerning the growth of the various parts of plants are to be found in Treviranus, Phys. II, pp. 152 ff. An extract from more recent investigations into various aspects of growth by Bravais, Hartingh, Münter, Grisebach, and Gräfe is to be found in Wiegm. Arch. 1844, II, 38.

6)

Cut off a lizard's tail or a limb, and it is replaced; a snail replaces its head, its tentacle. Where an animal cannot replace something, the form remains mutilated. The growth of the animal is calculated precisely to maintain a prescribed form and, where necessary, to reconstitute it. But a plant never regenerates a branch or a leaf that has been cut away in the very place from which it was removed. It drives forth instead another, perhaps differently formed, in a different place; its growth serves not so much to create particular organs for the

accomplishment of function as it is itself intended to be the functioning. What has grown is a thing past; if it is to continue to live, it must itself continue to grow.

7)

The plant displays in general a tendency to develop and arrange its parts in spiral form; and the spiral is by its very nature an open and unclosed form, whereas the forms underlying animal structure are more intrinsically self-enclosed. This too testifies that the growth of the plant is, in its essential disposition, less determined to conclude in a fixed and definite end-result than that of the animal. The distinction is again merely relative, for spiral forms do occur in the animal kingdom as well — in the coiled shells of snails, in horns, and so forth — though these are not dependent upon any unlimited growth; and even in plants the spiral tendency does not pervade everything and penetrate throughout; yet it manifests itself comparatively rarely in the animal kingdom, while in the plant kingdom it is far more frequent than a first glance might suggest.

In twining plants, the entire stem winds spirally around a support; in certain trees, the whole trunk winds spirally within itself (see further on); the arrangement of leaves ordinarily follows a spiral course around the stem, a phenomenon that has recently given occasion for extensive investigations (cf. XV.); the tubercles of the Mammillaria stand in spiral arrangement; certain flowers are spirally twisted before they open (aestivatio contorta); certain fruits, such as sword-beans, or parts of fruits, such as the scales of pine cones, display a tendency toward spiral torsion or arrangement; ferns

unroll in a double direction — first from a spiral of the midrib, then from the inward-bent, springy lateral aspect; the entire existence of the Oscillatoria is spiral; older filamentous branches of Lycium europaeum incline toward spiral winding; the leaf-stalks of the Lombardy poplar, when stung by an insect, twist spirally; in a long potato, all the eyes were observed ascending in a spiral sequence from left to right; certain plant hairs are set with small warts that stand distinctly upon spiral lines. — Within the interior of plants we find the system of spiral vessels (cf. p. 35); in mosses, liverworts, Chara, and ferns, the spiral spermatozoids; in the cells of Chara, even the starch granules assume a spiral arrangement; and the fluid currents observed in the cells of Chara likewise pursue a spiral direction, and so forth. — Numerous instances of spiral tendency in plants are collected in Goethe's treatise: "Ŭber die Spiraltendenz der Vegetation" (Collected Works, Vol. 55, p. 99). Regarding the regularly spiral twisting of certain flowers before unfolding (aestivatio contorta), as well as of certain fruits, see in particular: Braun in the Flora, or General Botanical Journal, for 1839, p. 311.

8)

The plant is capable of drawing inorganic substances into its process of growth and of mastering them, whereas the animal is able to nourish itself and to grow only upon organic substances; the former builds up a living form anew, the latter merely rebuilds it. In other respects too it becomes apparent that the assimilation of substances in the growth-process of the plant plays an altogether different role than in that of the animal. On the whole, the various plants are presented

with a rather similar nutrition, yet they are capable of generating from it the most diverse substances within themselves — a capacity which presupposes particular acts of vital activity that may well be connected with specific determinations of the common feeling. Conversely, the various animals, though they enjoy the most varied nourishment, nevertheless all generate within themselves very nearly the same substances, and in their total number incomparably fewer than the plants. The substances contained in one and the same plant are, like the external appearances of its growth, highly variable according to season, habitat, age, and other circumstances; the finest medicinal plant, gathered at the wrong time or from the wrong location, has no effect whatsoever; whereas in the animal such considerations make little difference. There are even plants that alter their constituents very perceptibly in the course of the sun's daily passage, tasting sour in the morning and bitter in the evening.

"The leaves of Cotyledon calycina Rot (Bryophyllum calycinum Salisb.) in India are, according to Hayne, as sour as sorrel in the morning, tasteless toward midday, and bitter toward evening. Link found this confirmed and observed the same in Cacalia ficoides L., Portulacaria afra Jacq., and Sempervivum arboreum L." (Gmelin's Theoretical Chemistry, 1829, Vol. II, p. 1802.)

Cases are known in which the simple act of transplanting caused an almond tree, which had previously borne bitter almonds, to bear sweet ones. (Liebig, Chemical Letters, p. 173.)

The growth that bears the greatest resemblance to plant growth is perhaps that of the foetus in the maternal womb, inasmuch as it, like the plant, builds its organs for itself from the very beginning. This analogy, superficially apprehended, has naturally led at once to an equally superficial objection against sensation in plants. Foetal life equals plant life, therefore plant life equals foetal life. The foetus does not feel; therefore neither does the plant. One is thus quickly done with the matter — as though every analogy did not present, alongside the aspect of similarity, an aspect of difference equally deserving of attention.

The foetus forms itself under the influence of an alien life-force, draws its substances from an alien source of life, grows as the product and part of another body under the most uniform conditions according to a strictly maintained plan; the plant grows by its own power, prepares its own living substance for itself, grows in freedom under the most varied influences of the outer world — not indeed without a plan, yet in the freest unfolding of it. Therefore, instead of denying sensation to the plant by analogy with the growth of the foetus, one should rather from the outset decline to draw any such analogy at all.

The comparison of plant life in general with foetal life is all the less compelling, since a particular phase of plant life lays claim to such comparability with far greater right — I mean the life of the seedling within the seed while it is still borne by the mother plant. For already at this stage the entire plant-structure develops in radicle, stem, and plumule, which is as closely analogous as possible to the development of the

foetus in the egg while it is still contained within the maternal body. This seedling within the seed may well lack its own independent sensation, just as the foetus does; but if the foetus acquires such sensation after its emergence from the maternal body and its breaking forth from the egg into free intercourse with air and light, why should the seedling do so any less under conditions so entirely analogous?

It may not be without use to meet the rashness of conclusions in this field with the following observation. Suppose the analogy between the life of the growing plant and foetal life were so thoroughgoing that something might genuinely be built upon it — would one then have the right to conclude from it an absence of independent sensation in the plant? By no means; for one might with equal justification conclude, conversely, that the foetus possesses independent sensation. The assumption that the foetus has no independent sensation is itself nothing more than an assumption which, however probable it may appear to us, remains entirely unproven and thus cannot serve to prove or disprove anything else. It is said that experience furnishes us the proof: we no longer retain any memory of sensation from the foetal state. But what human being retains any memory of what he felt during the first weeks after birth? Does he therefore feel nothing at that time? Still less can we expect a human being to remember what he may have felt before birth — and by the same token, still less can we draw any proof against the occurrence of such sensation from the mere absence of memory of it. The faculty of memory itself develops only with birth; and in so far as we shall likewise attribute to the plant no proper facul-

ty of memory — as is to be discussed later (XIV) — the plant would in truth stand upon precisely the same footing as the foetus in this regard: the plant would lead the inner life of the foetus, and the foetus that of the plant.

I am, however, far from wishing to build anything upon the assertion of a truly independent life of sensation in the foetus; I maintain only that one can build equally little upon the contrary assumption, since every assumption in this matter must first be grounded through other and independent considerations.

Beyond the growth movements considered hitherto, the plant commands a great many other movements in the folding and unfolding, raising and lowering, bending and turning of its parts, which are not to be confused with growth movements proper, although, as everything in organic processes is interconnected, they are indeed related to them. We may, after all, distinguish two corresponding forms in the animal as well, to which the twofold form of plant movement in some measure answers. The animal can change its place entirely, but can also merely bring individual parts of its body into different positions relative to one another, turning and bending them, while it remains on the whole stationary. The former finds its analogue in the plant's extending itself further into space around, beneath, and above itself through growth, without, of course, being able to detach itself wholly from its point of origin as the animal does; the latter, when, without stretching itself forth by new growths, it brings those already gained into new positions. All parts of the plant above the earth are capable of such movements; the entire stem, the en-

tire crown turns toward the light in many species; in others the stem twines around supports; leaves rise in the freshness of morning and sink in the languor of evening; flower petals unfold in the morning and fold themselves together at night; the stamens of certain flowers incline toward the pistil when the time of fertilisation has come; there are leaves that catch flies by closing swiftly around them. Some such movements occur only under the influence of particular stimuli; others arise even without these, when the developmental period of the plant impels them; each plant behaves differently in this regard; some are so sensitive that they fold their leaves at the slightest touch; here these, there those parts are more supple, more irritable, and more mobile. There is an inexhaustible variety in all of this. Let us now bring forward the more interesting aspects, where the relation to instinct and sensation lies nearest, or where the resemblance to animal movement is greatest, always bearing in mind that we can expect no unlimited similarities whatsoever.

The plant is a light-thirsting being, and thus it does not content itself merely with directing its growth toward the light, of which we saw examples above; it employs, rather, every means at its disposal to bring itself into the most suitable position and orientation with respect to it. Even the most sober researchers have found herein a resemblance to the instinct of animals, though generally, to be sure, nothing more than resemblance.

Thus Decandolle writes in his plant physiology, II. 874: "Everyone has observed that the branches of plants cultivated in hothouses or even in rooms turn themselves toward the

windows, that the branches of forest trees strive toward the open and luminous places, that plants growing against walls show the tendency to turn away from them, and that plants in general seem, as if in consequence of a peculiar instinct, to aspire toward the light."

It is above all the upper surface of leaves that seeks the light. If one places a plant or a branch in such an artificial position that the leaves present their lower surface to the light instead of their upper, the petiole immediately, or in its absence the base of the leaf, performs a turning motion by which the natural position is restored (Bonnet). This tendency is so powerful that Knight observed a vine leaf, whose lower surface was exposed to the sunlight and every path back to its natural position blocked, making almost every possible attempt to turn its right side toward the light. Several times, after having sought over the course of a few days to approach it in a certain direction and having covered almost its entire lower surface by bending back its lobes, it spread itself out again and moved further from the glasshouse window in order to approach the light once more from the opposite direction (Treviranus, Beitr. 119).

Dutrochet relates in his Rech. p. 131: "I observed that when one covers the upper surface of the leaf of a plant standing in the open air with a small board, this leaf seeks to free itself from the shade by means which are not always the same, but are always of such a kind as must most readily and swiftly serve the purpose; thus it occurred sometimes through a lateral bending of the petiole, sometimes through a bending of the same petiole toward the stem. When the

board was too large for the leaf to escape from beneath it, the petiole bent down toward the earth, so that the light reaching the leaf laterally from beneath the board might strike it."

The same naturalist covered the terminal leaflet of a bean leaf (of Phaseolus vulgaris), which as is well known possesses three leaflets, with a small board. Since this leaflet was unable, owing to the shortness of its own particular stalk, to escape the covering by bending that stalk, this was accomplished instead by the bending of the common petiole. "When one sees," says Dutrochet, "how many means are here employed to arrive at the same end, one is almost tempted to believe that some intelligence is secretly at work, choosing the most appropriate means for the attainment of the purpose." That it is, moreover, truly a craving for light, and not a flight from the board, which comes into play in these experiments, is proved by the circumstance that when they were repeated in the dark no tendency whatever manifested itself to escape from the covering of the board.

In young leaves the turning occurs more swiftly than in older ones. Indeed, entire branches of trees can be displaced from their position by the tendency of their leaves to reorient themselves. (Dassen, in Wiegm. Arch. 1838. II. p. 159.)

According to the experiments of Bonnet and others, when a leaf is fixed in such a manner that it is in no way able to turn its upper surface toward the light, but is compelled to present its lower surface to it, the leaf perishes; indeed, the deterioration spreads from thence further over the branch. It is therefore truly a life-condition agreeable to the leaf which it seeks to secure through its proper orientation in the light.

Dassen (Fror. N. Not. VI. p. 51) has more recently conducted experiments by which he believes he can demonstrate that the movements of leaves which in the foregoing were attributed to the influence of light do not in fact depend upon it, but that leaves in general have a tendency to turn one of their surfaces upward, and ceaselessly strive to resume this position whatever the prevailing circumstances may be with regard to light, warmth, and moisture. Indeed, it does appear from his experiments that such a tendency exists independently of the influence of light; yet the experiments of Dutrochet and others cited above would seem not to be entirely explicable by Dassen's assumptions. For our purposes the discussion of this subject is of less importance, since these experiments are intended only to show how plants strive, after the manner of animals, to bring themselves into their natural conditions through purposeful movements, it being in essence immaterial whether these conditions relate to light, gravity, or anything else besides.

Among flowers, the sunflower has surely earned its name no less by its inclination to follow the course of the sun in its orientation than by its sun-like appearance. Athanasius Kircher even proposed to found a sundial upon this property.

The arrangement was to be as follows: in the middle of the floor of a large tub partially filled with water, an iron pin was to be fixed, and to this a considerable piece of cork fastened in such a manner that it might rest upon the water and turn freely about the pin. Upon this disc one was to fasten a sunflower together with its root in a vertical direction, or alternatively the stem might be passed through the cork. From the

stem itself, for the refreshment of the plant, several woollen threads were to hang down into the water. One was then to surround the flower with a metal ring, on whose inner face the hours were correctly inscribed according to the latitude of the place, so that the hand fixed at the centre of the clock might properly indicate them. This device was then to be placed in the open air in the morning with its north side turned toward the sun. The flower was then to rotate with the course of the sun and thereby indicate the hours.

Of course, this is only a kind of play; for it is not sunlight alone that determines the position of the sunflower — one sees quite enough sunflowers that do not turn toward the sun, just as an animal in its postures and movements is not governed exclusively by a single stimulus. Yet sunlight remains, in any case, a principal stimulus that influences the position of this flower, as it does that of many others. (Cf. the observation communicated by Hegel, p. 54.)

A great many herbaceous plants also move their stem and branches to some degree in accordance with the course of the sun, as for example Lupinus luteus, Reseda luteola, Sonchus arvensis, and others. (Van Hall, Elem. Bot. p. 28.)

As clear as the tendency of plant parts toward the light is in the cases hitherto described, there are nonetheless cases in which the light is rather fled — just as in the animal kingdom certain creatures, under certain circumstances, flee that same stimulus which others seek under most conditions.

Thus Mohl writes (Über den Bau und das Winden der Ranken, p. 26): "The tendrils of the vine, and according to Knight (Philos. transact. 1812, p. 314) also those of Cissus

hederacea, exhibit a peculiar remarkable quality, in that they do not turn toward the incident light as other green parts of plants do, but rather turn away from the side where the light falls. This phenomenon is all the more striking in that the clusters of flowers of the vine, from which the tendrils arise, show no such flight from the light. This bending back from the incident light is apparent not only when vine shoots are placed in a room that receives light from one side alone, but also to a very striking degree in vines grown in the open, where the tendrils show more or less a northward orientation, or, when trained against walls, are directed toward them . . . That this circumstance facilitates the grasping of supports is easily understood; but that this direction is solely the consequence of the influence of light is shown by the fact that even in quite free-standing vine shoots the tendrils turn away from the incident light — that when a vine shoot is placed beneath an open window, the tendrils turn backward toward the empty space of the room, and not sideways toward the wall of the window, the only body standing nearby. — This flight from the light seems to belong only to the tendrils of Cissus and Vitis; at least I (Mohl) could never observe, in the tendrils of passion flowers or of Cobaea grown in greenhouses into which light fell from one side only, that they turned either toward or away from the light. I noted the same also in Passiflora coerulea, Pisum sativum, Lathyrus odoratus, and in gourds that I cultivated in my room; though the stems of these plants bent strongly toward the light, the tendrils nevertheless extended uniformly in all directions."

According to Dutrochet, however, the stem tips of the hop (Humulus lupulus) and the hedge bindweed (Convolvulus sepium) likewise flee the light, as do the small rootlets of the germinating mistletoe seed. According to Payer, the roots of cabbage and white mustard do the same, as one observes when the seed of these plants is sown on cotton floating in a glass of water. Just as the stems bend toward the light, the roots turn away from it, so that the plant presents the form of an S. The roots of Sedum telephium turn away not from diffuse light but from direct sunlight. The roots of cress, however, are affected by neither diffuse nor direct light; yet where light does act upon the roots, the angle of inclination of the roots is always smaller than that of the stems. (Comptes rendus, 1843, II, 1043.)

Among the most interesting life-expressions of plants resembling instinct are those which twining plants display in seeking their supports, concerning which Mohl in particular has provided excellent information (in his work on the twining of tendrils).

A plant that has received from nature the disposition to wind about a support first extends itself, upon germinating from the earth, a short distance vertically upward, but then, as it continues to grow, bends the upper part so that it approaches the horizontal direction, while the lower part remains erect. This vertical part now begins to rotate about its own axis, so that its fibres assume a spiral arrangement. It is as with a piece of string held fast at its upper end and twisted about itself by the other hand; with the difference that in the plant the fixing is rather below, through its rootedness in the

earth, and the twisting is accomplished by the plant's own vital force. Naturally the part bent toward the horizon is thereby carried in a circle, and by means of this feeling motion the plant seeks its support. Should one circuit fail to find such a support, the plant repeats the movement several times, continually extending its sensing organ further by continued growth. For a support might stand in a circle of greater radius that was absent in the smaller one. Should the plant find none by such means, it abandons the attempt; it becomes too difficult to keep the now overly elongated sensing organ suspended above the ground. The plant lays itself down upon the soil and creeps along it until it finds a support. When it has found one, it perceives this immediately, for it at once ceases to creep further and now runs upward around the support. Were it to perceive nothing of this, and were it not drawn to run up the support, it would surely continue in the direction it had been following, where it had so much more ease and needed not to strive against gravity.

In the act of entwining the support, the rotation of the winding stem about itself — which causes the fibres to describe a spiral line — then ceases as well, as may be ascertained by drawing ink lines along the winding stem; these remain parallel to the axis. (Mohl, p. 111.)

Of course the outcome may once again be presented — and indeed is habitually so presented — as if the physical stimulus of the support simply drives the plant to run upward, with no sensation involved. But this is the old story once more. With equal right one might regard the squirrel's running up an oak trunk as merely a somewhat more compli-

cated interplay of the stimulus of the light rays falling from the oak trunk into the squirrel's eye, and of the trunk itself upon the still more complicated arrangements and movements within the squirrel. Indeed it seems, at bottom, rather less explicable how a dry stick can stimulate the twining plant to run upward, than how the light coming from a tree, and the living tree itself, can stimulate the squirrel to do so. And even if in both cases the outcome may be regarded hypothetically in such terms, one is not therefore compelled in either case to regard it in those terms alone. But I refer here to earlier discussions.

The plant now winds its way upward to the summit. Having arrived at the top, what will it do? The support is at an end; the need for one is therefore renewed, and the plant begins once more, as at the outset, to seek one. It first grows again a little way upward, then bends about once more and begins again to feel in circles, in order to find another support.

Some of the twining plants have the peculiarity of feeling their way in circles only to the right, and others only to the left, and they always wind accordingly in such a direction. Let a rod be placed to the left, close beside the feeler of a right-winding plant that is seeking its support, and the plant does not find it — indeed it moves away from it. This has been urged against the existence of an instinct. For, it is said, instinct would cause the plant to notice the nearby rod; instead it moves away from it. But the case proves only what we already know from other evidence: that instinct in its expressions is bound to natural endowments. The feeler naturally

has no eyes, and even the hungriest person does not see a piece of bread held behind his back — the blind person not even when it is held before his nose. But if an instinct told him there might be something to eat about him, he would feel about to find it, and might just as easily miss the bread as the plant misses the support, insofar as it is grounded in his nature to seek what he needs not by movements of the nose, but of the arms.

Many plants wind themselves around dead supports as readily as living ones; the dodder (Cuscuta), however, when newly emerged, distinguishes between the two and winds itself only around living stems. Why does it possess so different an instinct from other plants? Simply because its conditions of life are different. Other twining plants, as they climb upward, remain rooted in the soil and draw nourishment from it even when the support provides none. The dodder, however, after germinating in the ground, severs itself from it entirely, its subterranean roots dying away, and is thereafter capable of extracting nourishment only from living plants, through tiny rootlets it drives into them. Of what use, then, would a dead support be to it? The living stem, by contrast, it clasps with tight coils, draining it of its vital substance, and the host plant often perishes in consequence. How does the dodder then help itself? From the dead it can draw no further nourishment. It now begins to loosen its coils in the hope of perhaps reaching some other plant.

This last observation, which I do not find in Mohl's writings, was communicated to me by Professor Kunze.

Neither sun, nor moon, nor orientation toward the light exerts any influence upon the rightward or leftward direction of twining plants. That a single species should wind sometimes to the right and sometimes to the left had never come within the range of Mohl's observation. As far as his investigations extend, the species of a genus, though not invariably those of a family, wind in the same direction. The majority of climbing plants wind to the left.

Twining plants orient themselves toward the light less, in general, than other plants (cf. p. 142). They perform their circular movements, or wind themselves around their supports, even at night and in conditions of complete darkness (Mohl, p. 122).

The already-noted influence of youth makes itself felt in the twining of plants as well. The circular movements that the stem of a climbing plant executes occur only during the early stages of its development; thereafter it becomes firmer, turns woody, and can no longer coil itself around supports, even if one brings them into immediate contact with it.

The trunk of certain trees can also, even without a support, twist about its own axis as it grows straight upward, although such twistings are always drawn out at length and usually do not complete so much as a single full revolution. Since there is nothing particularly remarkable to be sought in this, one will not be tempted to see in it the expression of an instinct so clearly defined as that which drives twining plants in their endeavour to find a support. Yet there are points here, too, which are of interest, insofar as they call to mind the manner, half governed by law and half free, in which in hu-

man beings and animals innate dispositions develop and manifest themselves. The wood, one might say, does not behave woodenly in this process, but rather twists and bends itself, in response to inner and outer impulses, in a manner one may well regard as befitting the organic foundation for the development of a soul. This twisting does not, in fact, follow a simple, fixed rule, uniformly valid everywhere and for all time, but rather what one might call a living, fluid rule, which in part follows individual differences in the nature of the plant, and in part accommodates itself to changes in external circumstances in a manner never entirely calculable by us.

Let one take a walk around Leipzig along the avenue that chiefly consists of lime trees and horse chestnuts, and examine the horse chestnut trees there with some degree of attentiveness; one will then recognise, in very nearly all the deeper bark fissures and prominent bark ridges of any considerable length, the unmistakable signs of spiral torsion. (Particularly striking, among others, on several of the trunks standing between the Barfusspförtchen and the theatre. Where no significant fissures or ridges are present, traces of the spiral torsion may still often be discerned in the oblique direction, relative to the trunk's axis, of the smaller fissures.) The spiral torsion everywhere ascends uniformly from left to right, as seen by a facing observer. The direction of torsion is thus in the horse chestnut as firmly determined as in a herbaceous plant coiling around a stem. But the degree of torsion varies greatly among the same trunks, even when they stand side by side. In the lime trees of the same avenue, by contrast, one nowhere notices any decisive signs of torsion. If one proceeds further into

the Rosental and examines the trunks of the hornbeam (Carpinus betulus), which occur there in abundance, most will betray no decided signs of torsion; in some, however, it is very plainly apparent, yet in such a manner that trunks are found equally where the torsion ascends from left to right and where it ascends from right to left. In the course of one longer walk I counted twenty trunks of the former kind against fourteen of the latter. The preponderance of the former over the latter was attributable solely to the circumstance that in one particular district only left-twisted trunks were to be found, where conditions especially favourable to the development of that direction must therefore have prevailed; whereas elsewhere I encountered left- and right-twisted trunks in the most irregular alternation, and twice among them came upon the case of two oppositely twisted trunks standing immediately beside one another, having grown, to all appearances, under entirely similar conditions. The oaks of the Rosental display nothing of torsion. If one combines these various cases, one will find in them the following conclusion, which holds equally for the development of dispositions in animals and human beings. Where a disposition prevails with great distinctness in a particular direction, nothing has power to divert it; but where the disposition is not determined, it takes this or that direction of development according to the variation of external circumstances, without those circumstances alone being sufficient to account for it.

According to Goethe's account, the birch likewise twists spirally from left to right without exception, all the way to the crown; which is to be recognised not so much on the exterior

as when the trunk is split open. Birch trunks standing in the open display the spiral torsion far more conspicuously than those growing in dense thicket. He also mentions that, according to the reports of foresters, cases occur among pines as well in which the trunk from base to crown takes on a twisted and winding direction; it had been supposed, when such trees were found near the Brane, that severe storms were the external cause; yet such trees are found in the densest forests also, and the occurrence repeats itself in a certain proportion, such that one might reckon its appearance at between one and approximately one and a half per cent of the whole. Spiral torsion also occurs, according to Goethe, in old chestnut trees and in trunks of Crataegus torminalis (Goethe's Collected Works, vol. 55, p. 123). I myself found a trunk of field maple (Acer campestre) considerably twisted. Many species and individual trees, however, display at least outwardly nothing of torsion.

Among the movements of folding and bending that plants undertake of their own accord in the course of their development, the unfolding of the corolla at the moment of flowering, and its closing or other change of position of its parts in what is called the sleep of plants, is of pre-eminent interest. One must not, however, forget to direct one's attention to the flower-stalks and the leaves as well. There are altogether graceful relationships to be observed here, which admittedly permit us to divine rather than truly to trace their significance for the inner life of plants. Let us call to mind the ascending and descending movement of the water lily and the lotus blossom, connected with the course of the sun, from night to

day. What the water lily does in the water, as Linnaeus observed, the coltsfoot (Tussilago farfara) does out of the water; that is, it closes its flowers at night and bends them downward, resembling a sleeping human being who closes his eyes and bows his head. The lowering of flowers at night is in general not uncommon, though it does not everywhere accompany the closing of the flowers; just as, conversely, many flowers close without lowering themselves. Each does it after its own fashion.

In many plants, the manner in which the flower-stalk is positioned is connected with the period of blooming. The poppy bears its bud deeply bowed so long as it has not yet opened, but stands erect and stiff once it has come into bloom; notwithstanding that the flower is heavier than the bud — much as a maiden modestly inclines her little head, only to bear it one day proudly aloft as a woman and to glory in her adornment. In the hyacinth that is about to bloom, all the flower-buds press themselves closely around the mother-stem as though forming a clenched fist, and are still as green as the leaves themselves; as though the smallest intimation of what is to come should be withheld from them. But when they open into bloom, each bends away from the others as far as possible, the better to enjoy in full independence the air and light and whatever else is offered, and the green is transformed into enchanting colour. Euphorbia oleaefolia Gouan allows its head to droop throughout the winter and announces, by its rising again (according to Draparnaud), the return of spring (Decand. II. 628). In the genus Phaca and certain other Leguminosae, the flower-stalk twists during the

ripening of the pod in such a manner that the upper suture of the fruit, which alone opens, becomes the lower, thus making it possible for the seed to fall out. (Decand. II. 623.)

Of particular interest likewise is the protection which certain plants, in their sleeping state, afford to their delicate parts through the positioning of their leaves — either by raising the leaves around the stem or the tip of the branches to form a kind of funnel beneath which the young flowers or leaves are sheltered (Malva Peruviana), or by the uppermost leaves bending downward and arching like a vault over the young shoots (Impatiens noli me tangere), or by the leaflets of a compound leaf folding upward in such a manner as to enclose the blossoms between them (Trifolium resupinatum and incarnatum, Lotus tetragonolobus and ornithopodioides, among others).

For further particulars concerning the so-called sleep of plants, see the supplementary notes appended to this section.

Such bendings as the plant's parts perform have been sought to be explained by unequal moistening, or unequal warming, of the fibres on different sides of the stem. How little this suffices is demonstrated not only by the so unequal behaviour of different plants under the same circumstances — which is altogether analogous to the equally diverse behaviour of different animals under the same conditions — but also, in a most striking manner, by the case of Vallisneria spiralis, whose stem rolls and unrolls itself in a spiral form even beneath the water.

All the movements of growth, bending, turning, and twining in plants that have hitherto been described take place only

slowly in comparison with the movements that man and animal are capable of making. Man, the animal, quickly extends the arm, the claw, seizes what seems serviceable, and withdraws it again with equal swiftness. What rapid, ever-changing movements in handling, running, leaping! Of all this there is nothing in the plant. It extends its roots only slowly, raises its stem only slowly, climbs a support only gradually, follows apparently with sluggishness the stimuli that act upon it, and remains more steadfast in the positions it has once assumed. Yet this affords no ground for concluding that its sensations and impulses are weaker, inasmuch as strong sensations and impulses can express themselves equally well in strong inner changes and movements as in a great range or great swiftness of outward movement — into which last it had little occasion to translate itself, given the firm and narrow sphere of the plant's activity. Let one observe a man in the act of deep thought, how it labours within his head; assuredly, though we cannot see it, something flows back and forth through the countless fine channels of nerve and vessel that constitute his brain — for what else would they be there for — yet outwardly nothing is visible. How deeply a woman often feels within herself, and how little she often shows outwardly; not that nothing stirs within her bodily frame; on the contrary, the tears perhaps press with force toward the eye, a convulsion passes perhaps through all her limbs, the heart perhaps seems about to burst — indeed there are instances in which it has truly burst amid inward emotional agitation, through the violent pressure of the blood — yet all this may occur without any outwardly visible movement. Such inner

changes are in truth a far more essential expression of sensation and of felt impulse than any outward ones can be, since the outward ones are themselves but the effluents of the inner. When someone strikes another in fury, it is not the movement of his arm in which the emotional agitation finds its immediate bodily expression, but something that is stirred by anger in the brain and that, by means of the nerves issuing from the brain, first sets the arm in motion. The arm may be restrained, and the anger only continues with heightened force; could one restrain the movements in the brain, one would, by virtue of the mutual conditioning of mind and body that obtains here below, thereby restrain the anger itself — as is at once proven when an excess of rage brings on a stroke, whereupon all movements in the brain and all passions alike come to a standstill.

It is not, therefore, a matter of observing strong outward movements in order to conclude that strong impulses and sensations exist; rather, it is the inner movements that are to be considered — movements which can certainly, in proportion to the occasions and purposes that call for it, break forth into outward movement, but by no means always do so.

If we may draw an inference from ourselves, it will be, moreover, not so much the magnitude of the inner movements in themselves as the magnitude of the changes in which they are caught up, or in the production of which they are engaged, that is connected with the strength of sensations and felt impulses. When everything proceeds in its ordinary course within us — though blood and vital spirit may flow swiftly enough — we derive from it nothing but a general

feeling of life; but every particular change, or every striving toward such change, however brought about, whether by an outward sensory stimulus or by inward occasion, we feel forthwith all the more vividly the greater the force that proves active in calling forth the change. If we take this into consideration — which is certainly valid in general terms, however much a thorough clarification still remains wanting — we shall not fail to discover the signs of vivid sensations and vividly felt impulses even in the outwardly so slight movements of the plant; for these outwardly slight movements are connected with a manifold play of inner changes and with a great urge toward such changes. It is known that every voluntary bending and turning of plant parts stands in relation to modifications of the flow of sap and to still finer modifications reaching into the chemical domain. And what inward urge must it require to alter the form of the plant from within outward, in every direction and enduringly, as is the case in the upward growth of the stem and in the impulse toward bud and blossom. Indeed, experience demonstrates directly the force of this urge.

The sap that rises for this purpose is capable, by the force with which it does so, of lifting great columns of water and mercury; and the root that descends is capable of penetrating into heavy mercury and of forcing its way through solid earth. Through germinating peas, couch-grass, and the like, firm soil is often heaved up in clods. Now we observe that this sap, rising or descending with such violence into the delicate sheaths of bud or root-shoot, does not rudely burst them asunder; and thus this force is employed in the further driving forth of

the bud or root-shoot and in the unfolding of leaves and blossoms themselves.

Everyone knows that when a grapevine is pruned, water flows forth from the cut surfaces where the wood is laid bare, and that in unpruned trees the sap does not flow out but serves instead to develop the buds. Hales wished to determine with what force the nutritive sap ascends within the stems. To discover this, he fitted a tube to the upper end of a seven-inch length of grapevine and sealed it so carefully with putty that the water pressing out of the vine could not escape, and was therefore compelled to collect in the tube, driven upward from below by the liquid newly streaming from the trunk. In one experiment the water rose twenty-one feet high; in another, mercury poured into the top of the tube was raised thirty-eight inches by the water forcing its way up through the vine. In this latter case, the force driving the crude nutritive sap must suffice to withstand a pressure of two and a quarter atmospheres. According to Hales's calculation, it is five times stronger than the force which drives the blood through the femoral artery of a horse.

Senebier raises doubts against Hales's experiments, founded upon the observation that if the nutritive sap truly ascended with the force attributed to it on the basis of the experiment cited, it would be extraordinary that it could be arrested by the delicate envelope of a bud. But (says Decandolle) it is evidently not the bud-sheath alone which arrests it; there is the further circumstance that the sap is employed in the development of new parts, and that, since it does not flow out

of the plant, no such great quantity is absorbed through the root. (Decand. Physiol. I. 76.)

When a seed of the sweet-scented vetchling (Lathyrus odoratus L.) is allowed to germinate over a vessel filled with flowing mercury, and is held firmly in place by some easily contrived apparatus, the radicle of that seed directs itself, according to Pinot's experiments, perpendicularly toward the ground and penetrates into the mercury, notwithstanding that the latter is considerably heavier than the former. (Journ. de pharm. 1829. T. XV. p. 490; Annalen der Gewächskunde Band IV. H. 4. S. 408. 409. Cf. Ann. des Sciences nat. 1829; Revue bibliographique 129. 130.)

When hyacinths are grown in small pots, the bulb is often seen raised considerably above the soil, borne up by the small roots that appear to have elongated against it. This peculiarity of growth is likewise observed in palms. In Martynezia caryotaefolia H.B.K., the stem is sometimes raised two feet above the ground, resting upon the converging rootlets as upon supports. The same phenomenon is observed in Iriartea exorhiza and I. ventricosa Mart. (Treviranus, Phys. II. 157.) These appearances depend upon the fact that the roots, when in their effort to extend themselves downward they encounter an obstacle, relieve themselves by lifting the plant. One may see from these examples that the combined force of root growth is sufficient to raise entire plants upward.

When a vertically stretched string is used as a support, twining plants whose stems are not too slender possess the force to alter the straight direction of the string by the pressure they exert upon it as they wind themselves about it, so

that it likewise assumes the course of a spiral line, just as does the stem wound around it. (Mohl, Über das Winden der Ranken, p. 113.)

Dassen placed freshly cut branches of Faba vulgaris, Oxalis stricta, Lupinus albus, and Robinia pseudoacacia upon water at six o'clock in the evening, in such a manner that at least some of their leaves, which by virtue of the sleep of plants were inclined to fold themselves together, floated perfectly flat with their dorsal surface upon the water. Forthwith the leaves appeared to exert their forces in order to assume the nocturnal position. Thus the leaves of the first-named species curved themselves in the effort to detach from the surface of the water, yet were in no wise able to raise themselves entirely clear. The second species made the same movement, by which the leaflets fell to the side. The leaflets of the third species were unable to free themselves from the water, but pressed the point of their attachment so far downward that they assumed nearly the same position as they would outside the water. The last of the named species could not, owing to the resistance of the water, move the leaflets downward, but by a counter-reaction raised the common petiole somewhat aloft. By more precise experiments Dassen found that each of the leaflets of Faba vulgaris is capable of lifting three grains more than is necessary for the movement of closing the leaf. (Wiegm. Arch. 1838. I. 218.)

Even outwardly, the changes which a plant undergoes within a given time through growth are by no means so inconsiderable as they may seem to many. A tree that puts forth its shoots in spring labours simultaneously upon a thousand

leaves, each growing forward at every moment; the great change, taken as a whole, does indeed escape the eye because of its equally great distribution, since it amounts to but little at any single point. Yet the great sum of all these small changes is, taken together, something very considerable. Let us imagine that the tree were to employ all the material it absorbs and all the force distributed throughout its growth solely and always to produce one leaf at a time; when that leaf was complete, another would begin to grow in a different place in the same fashion. This would appear to us far more like voluntary putting-forth, like forming; and yet the only formal difference that exists is that the plant, instead of exercising the same freedom at one place, exercises it at all places simultaneously, distributes force and material on all sides, instead of concentrating them each time preferentially upon a single point.

The soul of men and animals is, even without being continually stimulated afresh by new external impulses, engaged in a play of continuous changes, which expresses itself in a ceaseless play of bodily processes, concealed from our gaze but well attainable through inference, and residing in particular within the brain. I recall only briefly that one such play falters with the other, just as on the other side it also grows in vivacity therewith. But this restlessly mobile play likewise leaves behind it enduring changes. The mind builds itself ever further through its own activity, organises itself ever more finely and richly; yet it cannot do so otherwise than while its bodily foundation does the same. We must indeed follow this more with spiritual than with bodily eyes, as one might say

that ever finer leaves and blossoms form themselves into the organisation of the brain, in proportion as the spiritual organisation drives forth such things; they pass into a fineness that the microscope cannot pursue; but when disease destroys them, it destroys together with the bodily leaves and blossoms for this world the spiritual ones as well.

What we perceive here in our spiritual domain with the utmost clarity by virtue of our self-consciousness, yet in the corresponding bodily domain with the utmost concealment by virtue of its closure from our own senses, that we perceive, inversely, in the case of plants within the spiritual domain most concealed from us, by virtue of the closure of our consciousness against theirs, yet in the bodily domain most openly at work. The plant unfolds before us freely and in full daylight the bodily process of formation to which there is bound, in its case, the continuous and spontaneous flow of its inner life; it spreads that process clearly before us, drives forth its leaves and blossoms openly outward, which our brain drives, in a wholly different form, hidden inward. Undeniably, to the latter activity there is attached a higher spiritual, to the former a more sensuous process of the soul; but in respect of continuous progression, the two stand equal. And this is a circumstance of importance. A soul always desires something to do. Thus the soul of the plant likewise lacks no want of constant occupation.

In a certain sense, nature has merely distributed differently between the animal kingdom and the plant kingdom that which is conspicuous in the expression of movements of the soul. Men and animals conceal within themselves the entire

immediate bodily expression of their soul's movements, yet display in strong, vivid, individual motions, in the play of limbs and countenance, offshoots thereof directed outward, which serve us in turn as all the more distinct signs of their soul's activity. In plants, such isolated, vivid offshoots of inner movements recede into the background; instead, in a continuous quiet play upon the surface, they unfold far more of the immediate expression of their soul's life and weaving. The difference is, of course, as all differences in nature, only relative. This one must never forget.

Indeed, the plant kingdom is not entirely without relatively rapid and conspicuous movements, which occur in particular as a consequence of stimuli (of which more in the following section); but even without any external irritation, certain plants exhibit, under particular circumstances, movements bearing the appearance of spontaneity. To this class belong certain movements of the reproductive organs of plants, of which we shall speak in the eleventh section; various movements within the domain of the lower plants, to be mentioned in the twelfth section; and the movements observed in Hedysarum gyrans, which will be discussed at the close of the supplements that follow (p. 127).

On the Sleep of Plants.

Here now the most interesting and important observations on this subject. For more detail, see the textbooks of plant physiology, as for example Treviranus II. 750; Decandolle II. 25. — Particularly comprehensive is a Dutch work on the subject by Dassen, abstracted in Wiegm. Arch. 1838. I. 214. 358. II. 159. — Among more recent treatises,

compare Dutrochet in Comptes rendus 1843. 11. 989, and Fror. N. Not. nos. 13 and 14 of Vol. I. — Foe in Comptes rendus 1846. T. XXIII, No. 12. (Fror. Not. No. 13 of Vol. XL.) — Fritsch in the Transactions of the Bohemian Society of Sciences 1847. 5th Series. Vol. 4.

The phenomena of so-called plant sleep consist, in general, in an altered position of the leaf or floral parts, or of both, from day to night.

The phenomenon of such alterations is not confined to any particular order, genus, or structural type of plant, but occurs among the most diverse vegetation, though more commonly in certain families than in others; yet according to the nature of the plant and its parts, different positions are assumed. As a general rule, one may perhaps venture to state that plant parts, in the absence of light, tend to return as closely as possible to the position they occupied in the bud, and that this position is assumed with greater exactness the younger and more delicately formed the leaf; in older and more robust leaves, the differences between day and night are slighter, while in perennial and leathery leaves they disappear altogether.

Sleep of the Leaves.

By far the most frequent and striking instances of the phenomena belonging here are found in plants with compound leaves, especially among the Leguminosae and Oxalidaceae. The time at which the transition from the diurnal to the nocturnal position takes place, and vice versa, is regulated by the rising and setting of the sun, and is in general far more regular than the opening and closing of flowers. Here one must

not, however, overlook the fact that plants transplanted from foreign climates into our own will generally continue to open and close their leaves at the hour to which they were accustomed in their native land. Thus in our greenhouses one may observe, at six o'clock in the evening in the middle of summer, certain plants closing their leaves, although neither light nor warmth has in the least changed, while in winter they open them again in the morning at their accustomed hour, though it is still quite dark. Our indigenous plants, on the other hand, regulate themselves by the sun. The changes in the orientation of leaves are closely bound up with the health of the plants, and especially with that of the leaves themselves; the more vigorous the plant, the more regular and the less dependent upon external influences its daily movements will be. As the leaves age in autumn, the movements change, cease altogether, or lose their former character. This holds particularly also of plants kept indoors through the winter, whose leaves then exhibit little or no perceptible difference between day and night. Young leaves, before they have fully developed, invariably occupy the position which they will later assume only at night. In the early period following their development they display the greatest degree of this movement, both in the speed of the motions and in the completeness of their execution.

With regard to the attitude of the leaves in the sleeping state: simple leaves sleep either by raising themselves out of the horizontal position, which is their natural one, or (less frequently) by bending backwards towards the stem, and both these modes occur in very varying degrees in different

plants. The former is found to a marked degree in Sida Abutilon, Oenothera mollissima, Atriplex hortensis, Alsine media, and several Asclepiadaceae, and to a lesser degree in Mandragora officinalis, Datura Stramonium, Solanum Melongena, Amaranthus tricolor, Celosia cristata, and others. — The latter is found in Hibiscus Sabdariffa, Achyranthes aspera, Impatiens noli-tangere, a Triumfetta, and a few others. — Among plants with compound leaves, some sleep in such a manner that the leaflets on opposite sides of the common petiole fold upward together (Lathyrus odoratus, Colutea arborescens, Hedysarum coronarium, Vicia faba), or they droop and fold downward together, so that either their upper surfaces touch (Phaseolus semierectus, Robinia pseudacacia, Abrus precatorius) or their lower surfaces (all the Cassias). Finally, the leaflets may also arrange themselves in an imbricate manner along the length of the common petiole, and this occurs either in the forward direction, so that the upper surface of the rearmost leaflet partially covers the underside of the one before it (Tamarindus indica, Gleditsia triacanthos, several Mimosas), or in the backward direction, so that the leaflets bend back towards the base of the petiole and each anterior leaflet approaches the one behind it with its upper surface (Tephrosia caribaea).

In accordance with the compound nature of the leaves, compound movements may also occur. Thus in pinnate leaves both the leaflets and the common petiole may move independently, and in doubly pinnate leaves the partial petioles as well. Only a few examples are known, however, of leaves possessing more than one moveable part.

The movements of the leaves and leaflets of many plants — though by no means all — especially those with compound leaves, are brought about with the particular cooperation of a small swelling (the leaf-cushion or pulvinus) situated at the base of the stalks or stalkelets. The highly interesting experiments and results of Dutrochet and Dassen concerning the mechanism of this action have, however, found no adequate confirmation in the experiments of Meyen and of Miquel (Wiegm. Arch. 1839. II. 88. Meyen, Physiol. III. 538). Dassen believes he has established (Wiegm. Arch. 1838. I. 223. 325) that the movement is connected with changes in the circulation of the sap and in the production of carbonic acid.

Moisture in general promotes the nocturnal position (Dassen). With respect to the influence of light and warmth, variable results have been obtained according to the nature, intensity, and duration of their application or withdrawal, and according to the constitution of the plants. In most cases the mobile leaves do not appear to assume the sleeping state through mere deprivation of light alone; yet this was found to be the case in certain instances. (For experiments on this point see Wiegm. Arch. 1838. I. 225.) Cases have even been observed in which bright sunlight caused the leaves to close (in Robinia and Mimosa pudica according to Sigwart, Reil's Arch. XII. 33., in species of Oxalis and Lotus according to Dassen, Wiegm. Arch. 1838. II. 216.), a phenomenon which some have termed a midday sleep.

The leaves of certain plants are moreover particularly sensitive to meteorological influences, so much so that they have even been proposed as indicators of weather (see below, Plant

Barometers). The sensitivity of certain leaves to mechanical and other stimuli is treated in the following section.

In irregular flowers, especially those of the Scitamineae, Orchidaceae, Labiatae, Personatae, and Papilionaceae, no phenomena of sleep have yet been observed.

In some flowers the sleep manifests itself solely in the fact that, while they stand erect during the day, at night they turn their opening toward the horizon or even toward the earth. (Euphorbia platyphyllos, Geranium striatum, Ageratum conyzoides, Ranunculus polyanthemos, Draba verna, Verbascum blattaria, Achyranthes lappacea, Thlaspi bursa pastoris, Alyssum montanum, Monarda punctata, Heracleum absinthifolium, and most conspicuously Tussilago farfara.) This drooping, however, does not rest upon any relaxation of tension; for if one attempts to raise the sunken stalks upright, they spring back again, as though they were held in a state of tautness. The sleep of blossoms is most frequently exhibited in the closing or folding together at night of flowers that stood open during the day; there are also certain flowers in which the inclination of the flower-stalk combines with the closing of the bloom (as in Nymphaea alba and Tussilago farfara). Ray-flowers sleep by the ray either bending backwards toward the flower-stalk (the common chamomile, the dog chamomile, and other species of Anthemis and Matricaria), or by the margins of the ray rolling inward on the upper side (Gorteria pavonia). There are certain plants in which the closing or rolling of the petals occurs not at night but, inversely, in full bright sunshine, and in the evening they spread again (the species of Mirabilis, of Silene and Cucubalus, especially

the large-flowered kinds of these latter two). The rarest occurrence is that the entire limb of the corolla becomes crinkled, as if it had withered, so that one who sees such a flower in its waking state would no longer recognise it as the same plant (Commelina coelestis, Mirabilis jalapa and longiflora, Oenothera tetraptera, and others).

Some flowers are essentially dependent in their opening and closing upon external, and particularly atmospheric, influences, and observe no entirely fixed hour in these movements. Linnaeus, who investigated the sleep of plants with especial care, called them meteoric flowers (see below: Plant Barometer). Others open in the morning and close in the evening; the hour of their opening and closing, however, shifts with the lengthening and shortening of the days. These he called tropical. Still others, finally, open and close always at determinate, unvarying hours. These he called equinoctial flowers, and assembled them, so far as he had opportunity to observe them himself, in a table upon which he founded his Flower Clock (Horologium florae) (see below). If one compares his observations, made at Uppsala, with those which De Candolle conducted with a number of plants in the vicinity of Paris, it is seen that the equinoctial plants — for example, Papaver nudicaule, Nymphaea alba, Mesembryanthemum barbatum, and Anagallis arvensis — opened their blossoms at Paris at the same hour as at Uppsala. Likewise R. Pulteney, upon repeating Linnaeus's observations in England, found them confirmed, with only a few deviations. Even in a hothouse where the same degree of warmth is maintained

throughout, and even when the shutters are closed, the equinoctial flowers open and close at their accustomed hour.

Flower Clock.

For the practical arrangement of a Flower Clock it has been proposed to plant the requisite species in a circular bed, ordered according to the hour of the opening and closing of their blooms, with the entrance facing north. The necessary particulars follow (after Reichenbach), though one must not, of course, expect the hours to be met with strict punctuality.

I. Plants whose flowers open in the forenoon:

From 3 to 5 o'clock: Tragopogon pratense L. — From 4 to 5 o'clock: Thrincia tuberosa D.C. (Leontod. tub. L.); Helminthia echioides Gaertn. (Picris echioides L.); Cichorium intybus L.; Hemerocallis fulva L.; Crepis tectorum L. — From 4 to 6 o'clock: Picridium tingitanum Pers. (Scorz. tingit. L.) — From 5 to 6 o'clock: Sonchus oleraceus L.; Leontodon taraxacum L.; Barkhausia alpina Mnch. (Crepis alpina L.); Tragopogon crocifolium L.; Rhagodiolus edulis Gaertn. (Lapsana rhagod. Scop.); Convolvulus sepium L. — After 6 o'clock: Hieracium sabaudum L.; Hieracium umbellatum L. — From 6 to 7 o'clock: Hieracium murorum L.; Barkhausia rubra (Crepis s. Hostia rubra Mnch.); Sonchus arvensis L.; Sonchus palustris L. — From 6 to 8 o'clock: Alyssum sinuatum L.; Leontodon autumnalis L. — After 7 o'clock: Lactuca sativa L.; Nymphaea alba L.; Anthericum ramosum L. — From 7 to 8 o'clock: Geracium praemorsum Schrbr. (Hierac. praem. L.); Sonchus alpinus L.; Hypochaeris maculata L.; Hedypnois rhagodioloides W. (Hyoseris hedypn. L.); Mesembryanthemum barbatum L. — After 8 o'clock:

Hieracium pilosella L.; Anagallis arvensis L.; Dianthus prolifer L.; Hypochaeris glabra L. — From 9 to 10 o'clock: Calendula arvensis L.; Portulaca oleracea L. (According to others, 11 o'clock.) From 9 to 12 o'clock: Drosera rotundifolia L. — After 10 o'clock: Alsine rubra Whlnb. (Arenaria rubra L.); Mesembryanthemum crystallinum L. — From 10 to 11 o'clock: Mesembryanthemum linguiforme L.; Papaver nudicaule L. (According to others, 4 to 5 o'clock); Hemerocallis flava L.; Hemerocallis fulva L. — After 11 o'clock: Ornithogalum umbellatum L.; Calendula chrysanthemifolia Vent. — From 11 to 12 o'clock: Tigridia pavonia Pers. (Ferraria tigr.).

At 5 o'clock: Mirabilis jalapa L.; Pelargonium triste Ait. — From 6 to 7 o'clock: Cereus grandiflorus Mill. — From 7 to 8 o'clock: Mesembryanthemum noctiflorum L. (According to others, 10 to 11 o'clock.)

At 8 o'clock: Leontodon taraxacum L. — At 10 o'clock: Picridium tingitanum L.; Lactuca sativa L. — From 10 to 12 o'clock: Cichorium intybus L.; Sonchus arvensis L. — After 11 o'clock: Tragopogon crocifolium L. — From 11 to 12 o'clock: Sonchus oleraceus L. — After 12 o'clock: Sonchus alpinus L.

IV. Plants whose flowers close in the afternoon and evening:

From 1 to 2 o'clock: Hieracium umbellatum L.; Barkhausia rubra Dec. — After 2 o'clock: Helminthia echioides L.; Hieracium murorum L.; Hypochaeris maculata L.; Geracium praemorsum Schrbr. — From 2 to 3 o'clock: Alsine rubra Whlnb. — After 3 o'clock: Thrincia tuberosa D.C.; Anagallis arvensis L.; Calendula arvensis L.; Calendula chrysanthemifo-

lia Vent. — From 3 to 4 o'clock: Anthericum ramosum L. — After 4 o'clock: Alyssum sinuatum L.; Nymphaea alba L. — After 5 o'clock: Hieracium sabaudum L. — After 7 o'clock: Leontodon autumnalis L. — From 7 to 8 o'clock: Papaver nudicaule L. — At 12 o'clock (midnight): Cereus grandiflorus Mill. (Reichenbach, Die Pflanzen-Uhr. Leipzig, Voigt und Fernau, 1846.)

Plant Barometer.

Rain is to be expected when Hibiscus trionum L. does not open; when the calyces of Carlina acaulis L. close; when Pelletiera hygrometrica L., Oxalis acetosella L., and most other species of this genus fold their compound leaves; when clover raises its stems erect; when Lapsana communis L. does not close its flowers at night; when Draba verna L. and Ranunculus polyanthemos L. droop their leaves downward; when Anastatica hierochuntica L. spreads its branches; when Ranunculus repens L. and Caltha palustris L. contract their leaves; when the birches exhale a strong fragrance; when the confervae cover themselves with a green film; when the flowers of Asperula odorata L., dried in the shade and sewn into linen, emit a strong scent; when Galium verum L. swells up and likewise gives off a powerful odour; when the stalks of the capsules of Funaria hygrometrica Schreb., which in dry weather are wound about in a bent and twisted manner, unfurl and extend themselves (especially when the capsules are emptied). — Stellaria media Dill., in fair weather, raises its flowers upward at about nine o'clock in the morning, unfolds its leaves, and remains wakeful until near midday; when rain is approaching, however, this does not occur; the plant then

hangs drooping and the flowers remain closed. — Calendula pluvialis opens between six and seven o'clock in the morning and is accustomed to remain awake until about four o'clock in the afternoon. Should this occur, settled weather may be counted upon; but if it still sleeps after seven in the morning, rain is to be expected before nightfall. Certain species of the genus Sonchus give indication of fair weather on the following day when the flower-head closes at night, and of rain when it remains open. — Pimpinella saxifraga L. behaves in this respect like Stellaria media Dill. — Anemone ranunculoides L. opens its flowers in rainy weather; Anemone nemorosa L. bears its flowers nodding in overcast weather, erect in fair weather. — When the colour of the alders appears lighter than usual, cold and frost are to be feared; when they appear darker, a thaw is at hand. (Reichenbach, Die Pflanzen-Uhr, p. 12.) In Robinia pseudacacia, certain species of Lupinus, Mimosa dealbata, and Caesalpinia pulcherrima, the closing of the flowers in stormy weather has been observed. (Dassen.)

Movements of Hedysarum gyrans.

The Hedysarum gyrans (Desmodium gyrans), whose movements I shall here describe principally after Treviranus, Physiol. II. 765, is a small shrub with trifoliate leaves; the terminal leaflet is stalked and oval, while the lateral leaflets standing opposite one another are linear or lanceolate in form, almost sessile, and many times smaller than the terminal leaflet. Only these lateral leaflets display a remarkable movement, while the terminal leaflet exhibits merely the ordinary movements of so-called sleeping and waking. This

movement of the lateral leaflets manifests itself in an almost continuous alternating ascent and descent, proceeding the more vigorously as the warmth of the air is greater and the plant more vigorous; it is therefore interrupted during considerably cool weather, but otherwise continues alike in shade and in light, by day and by night, and even in winter within the hothouse. If cold water is poured over the branches of the plant, the movement ceases immediately, but may be instantly restored by warm vapour. The plant is likewise rendered, as it were, paralysed when exposed outside the warm house to the ordinary temperature. If a plant is placed in darkness for two or three hours, there arises (according to Humboldt) an acceleration of movement when it is subsequently returned to the light. If the terminal leaflet is set in motion by the wind, the movements of the lateral leaves cease. Mechanical stimuli, electric sparks, the magnet, volatile spirits, the anointing of the leaflets with oil, the binding and cutting of the stalk — none of these exert any influence upon the movement. According to Broussonnet, it is strongest at the time of fertilisation. The ascent of the leaflets proceeds more slowly than the descent; in general, moreover, the movement is not uniform, but pauses at times somewhat, and then advances, as though accelerated by a sudden impulse, for a few moments with increased vigour. Commonly, when one leaflet rises, the opposite one sinks; yet this is not invariably the case, and very frequently there is no connexion between the two movements, so that one leaflet may remain at rest while the other continues to move. The movement does not depend upon the integrity of the plant; for even when the main petiole is de-

tached from the stem, and even when the upper portion of the leaflet has been cut away, it continues for a time; and it is asserted that a leaflet will still move when it is fixed by its stalk to the point of a needle.

(Mirbel.) The actual instrument of movement lies in the swelling of the small stalks by which the lateral leaflets are attached to the main petiole.

The Hedysarum gyrans would moreover appear not to stand entirely alone with respect to these movements. Mirbel observes that when the leaves of Hedysarum vespertilionis, instead of being simple as is customary, consist of three leaflets — which is not uncommon — the two lateral leaflets exhibit a similar movement, though infinitely weaker than that of Hed. gyrans; something of the like kind seems also to occur in Hedysarum cuspidatum W. and H. laevigatum Nutt., and in H. gyroides.

Besides those spontaneous movements independent of the influence of light, there occur in Hedys. gyrans also movements dependent upon light, which, however, concern not the lateral leaflets but the main stalks and main leaves, and stand in no direct relation to the former. This movement consists in an erecting of the parts in the light, and in a sinking in darkness. It takes place at the joints by which the leaf is connected with the stalk and the stalk with the branch. The sensitivity of the plant to light is so great that, according to Hufeland's observations, even the reflection of the sun from a wall some twenty paces distant produced a perceptible erection, just as the interception of sunlight by an opaque body and a cloud passing before the sun caused a sinking of the leaves. In full

midday sun and under sunlight concentrated through a burning-glass, Hufeland observed a trembling movement of the main leaves and of the entire plant. (Dassen likewise states that he knows of no plant whose leaves turn so rapidly toward the light as Hed. gyrans and gyroides.) Moonlight, artificial light, chemical and mechanical stimuli had no influence upon this movement; electric sparks, however, did cause a sinking of the leaves.

* * *

One may stimulate with a needle or a feather, or allow a drop of water to fall upon, the inner side of the gaping lobes of the stigma — the terminal portion of the pistil — of a Martynia annua, a Bignonia radicans, or of certain species of Gratiola or Mimulus (as for instance glutinosus, aurantiacus, guttatus); the stigma immediately closes and after some time reopens of itself.

One may touch the genital column of Stylidium graminifolium, adnatum, or corymbosum — that column formed by the union of the pistil and stamens, and naturally curved downward. At the lightest touch it straightens the lower part of the curve and thereby springs upward to nearly the opposite side, after which it slowly returns to its former position.

One may touch the feathery leaf of the sensitive plant (Mimosa pudica) at the thickened base of the stalk, or may shake the leaf or the entire plant; it immediately folds its leaflets together and bends itself backward toward the stem. (A sensitive specimen was observed to draw its leaves together as though startled at the mere trembling of the ground caused

by a passing rider.) Here too the natural position gradually restores itself.

There are yet more examples of this kind, to be considered later; for the present, these may suffice.

For one who is able to apprehend the soul of plants only through gross analogies with the animal kingdom, these irritability-movements, so closely resembling those of animals, will always appear of peculiar significance. Even the most superficial analogy points them toward sensation. We, for our part, place the weight of this analogy far below what more general considerations must carry for us, and concede to our opponents that, taken by themselves, such movements could prove little or nothing. For once one is determined to deny a soul to plants, all manner of mechanical explanations may readily be applied to these movements — just as they may be applied with equal facility to analogous occurrences in animals — or they may be made dependent upon a so-called dead vital force, which is itself nothing more than a lifeless concept. More significant is the fact that irritability-movements of this kind are, taken as a whole, but exceptions within the plant kingdom; and yet the soul is surely not intended to be a mere exception within that kingdom. The grounds for the soul of plants generally must, however, be grasped not severally but in their connexion; and when more general considerations have already rendered such a soul probable, individual particulars that are in themselves little conclusive may serve as striking corroboration. Such, I believe, is the case with these irritability-movements of plants.

When the Gauls, upon their invasion of Rome, beheld the old senators sitting motionless in their chairs in the forum (Livy, V. 41), those senators appeared to them as no living beings at all — so still they sat — until one of the Gauls plucked Papirius by the beard, whereupon he struck at him with his staff. No Gaul doubted any longer. So it is, si licet magnis componere parva, with the plants. In truth nothing essential is lacking in the signs of ensoulment; it is only the stillness that makes us hesitant. But if we now pluck one or prick it, and it suddenly strikes out, that ought to convince us entirely.

If not every one of these movements occurs, we must remind ourselves that, even where it does occur, it is in truth already more than we have any right to demand. In general, plants are simply not constituted to express their sensations through conspicuous movements; they respond to their vital and sensory stimuli in a quieter manner, through the way in which they direct their growth, their colouring, and the formation of their substances accordingly — of which we have already come to know sufficient examples, and shall come to know yet more. Now, however, nature, having separated that which she intended to assign to the animal and the plant kingdoms, has also, in many a respect, interwoven them again — though unaccustomed and unwilling to draw strict boundaries in the main — of which many further examples will present themselves to us later (XII); and thus we find, at bottom, only one further confirmation of this in the manner in which the plant occasionally comports itself in response to sensory stimuli. For the rest, these movements provide a very satisfactory corroboration of the earlier observation that the

plant has no need of nerves for much that the animal requires them for. For indeed, in all stimulus-movements of animals, the nerves are essentially and necessarily involved. But if the plant requires no nerves for stimulus-movement, it will likewise require none for the sensation of stimuli. — Thus these movements are of significance to us in more than one respect.

To be sure, someone may argue that the circumstance that these movements take place without nerves, just as without muscles, proves most precisely that they are of an entirely different nature from the stimulus-movements of animals, and that consequently, if the latter but not the former are to be interpreted as indicative of sensation. And certainly both are very different in respect to the means by which they are brought about. But shall I repeat once more what I have already said in discussing the question of nerves — that nature delights in achieving analogous ends by the most varied of means? The stimulus-movement of polyps occurs even without muscles and nerves that are demonstrable throughout; and if something of the kind exists within them, it is nonetheless very different from that which is active in the stimulus-movement of higher animals (cf. Siebold, Vergl. Anat. 1.31). In the last analysis, nerves and muscles are themselves originally formed only from cells, just as are the structures involved in the irritability of plants. Thus the means are not even so entirely different.

What must be of greater importance than the comparability of the means is that the stimulus-movements of plants exhibit, in any case, all the essential vital peculiarities of those of animals. If analogy holds here at all — and what else

should hold — then the sensation bound up with the stimulus-movements of animals must also be demonstrated by extension for the so closely analogous stimulus-movements of plants. Let us therefore examine this correspondence a little more closely.

1) A distinctive peculiarity of animal irritability lies in the fact that it is excited in a similar manner by stimuli of the most varied kinds. A machine may indeed move when pushed, but not when burned, dabbed with sulphuric acid, or subjected to an electric shock; whereas a limb of an animal twitches in approximately the same manner whatever stimulus acts upon it; and the optic nerve perceives light whether real light acts upon it or a blow is dealt to the eye. It is precisely the same with the irritability of plants. A sensitive plant is induced to make the same movements by mechanical agitation, burning by fire, chemical stimuli of the most varied kinds, electric sparks, sudden exposure to full sunlight after previous sojourn in semi-darkness, rapid transition to heat as well as to cold, or the sudden admission of free air after prolonged enclosure — with the qualification only that such movements are stronger or weaker, and extend more or less widely, according to the intensity of the stimulus and the sensitivity of the plant. The same holds for other irritable plants, as will be shown below.

2) A thoroughgoing correspondence in the mode of action and intensity of the same stimuli is not to be expected between plants and animals, since differences in this respect already exist within the animal kingdom itself. But examples of significant partial correspondence are not wanting. In this

connection it appears particularly important that galvanism, that so peculiar vital stimulus for animals, is capable of playing a similar role — even with regard to the differential effect of the two poles — in irritable plants as well, and that strong electric shocks destroy the irritability in both alike.

The stimulation of plants by galvanism is, to be sure, impeded by the poor conductivity of plants; hence nothing is to be achieved with simple circuits; and even with regard to the effects of the pile, observers contradict one another. Yet Nasse has demonstrated (Gilberts Ann. XLI. 392) how the experiment succeeds reliably with Berberis and with the complete exclusion of all mechanical stimulation, as follows: a barberry flower is connected, by means of a needle inserted into its stalk, to the positive pole of a pile of approximately forty pairs, or its stalk is placed in a glass of water into which the wire from the positive pole of the pile is suspended, and a small piece of moistened paper is then brought into contact with the petal of the stamen that is to be stimulated; provided that all jolting and pressure is avoided, everything remains entirely undisturbed. One then gently lays the wire of the negative pole upon this little piece of paper. At once the corresponding stamen leaps across to the pistil, and frequently the neighbouring stamens follow simultaneously or within the next moments. The direct and gentle contact of the upper end of the petal itself with the negative pole wire — the circuit being closed — without the intermediary action of the paper, produces the same effect in irritable stamens; the result is less constant when the surface of the petal is directly touched. The introduction of the flower through the stigma

and stalk into the circuit is ordinarily without effect. A reversed application of the poles — namely, where the negative acts upon the stalk and the positive upon the petal — is less efficacious; in flowers that are already impaired by experiments or by prolonged standing of the stalks in water, the movement may then occasionally fail to occur once or twice after the circuit is closed, or may perhaps occur only a few moments after closure. This corresponds to animal muscular irritability insofar as, in the customary irritability of frogs' thighs likewise, the twitchings are more vigorous and more lasting when the negative metal is applied to the moving part and the positive to the nerve. A movement upon the breaking of the circuit — again analogously to frogs' thighs — could not be observed. When the barberry flower was freshly plucked and not yet impaired by repeated stimulation, the galvanically stimulated stamens required only two to two and a quarter minutes to withdraw from the pistil again and to recover their irritability.

The destruction of plant irritability by strong electric shocks was observed by Humboldt in the stamens of Berberis (Verf. u. g. M. u. N. II. 195), and Nasse observed a similar influence of water and spirits of wine upon the irritability of these stamens as upon that of frogs' thighs. The weakening effect of narcotic poisons might, on the evidence of various experiments — for example, those of Miquel and of Dassen on Mimosa (in Fror. Not. 1839, May, 207; Wiegm. Arch. 1838, II. 358), and those of Gärtner on Mimulus and others — be regarded as established; yet the experiments of Göppert (in Pogg. Ann. XIV.) appear to speak even more decidedly

against it, although he concedes a slight influence upon Mimosa. It is, however, certain, on the basis of experiments by Marcet, Jäger, Göppert, and Dassen, that plants are killed by prussic acid, arsenic, mercury, camphor, and others — applied in solution or vapour form in various ways. (Cf. Treviranus, Physiol. II. 724; and in particular the experiments of Bouchardat, in which, among other things, the great harmfulness of all mercurial compounds even in the smallest quantities is demonstrated: see Comptes rendus, 1843, II, p. 112.)

3) A stimulated animal part returns gradually of its own accord to its former state upon the cessation of the stimulus, yet more slowly than the stimulated state arises. Thus an oyster, when stimulated, closes its shells rapidly, but opens them only slowly; the green polyp, when stimulated, contracts rapidly, but extends itself again only gradually. The same is found, and in complete correspondence, in all stimulus-movements of plants. The rapidly moved parts return of themselves, but far more slowly, to their former position than the movement toward that position took place.

4) In animals, irritability is blunted or exhausted by frequent or prolonged stimulation and restored by rest, provided the stimulation has not been excessive. The same holds true for all irritable plants. Even phenomena of habituation to stimuli have been observed in Mimosa and other species.

A barberry stamen is capable of being stimulated anew only after approximately five to eight minutes, the sexual column of Stylidium only after twelve to fifteen minutes following an earlier stimulus; but through repeated stimulation the irritability becomes entirely exhausted. In the sensitive plant

as well, the movements occur ever more slowly and incompletely the more frequently one has compelled the same movements to take place in succession.

What may be interpreted as habituation consists of phenomena such as the following: Desfontaines observed in a sensitive plant which he carried with him in a carriage that it closed itself at first from the jolting, but finally remained open in spite of the continued motion of travel, as though it had grown accustomed to it. After the carriage had stood still for a time and then set off again, the leaves closed once more and then, during the renewed journey, opened again. Dassen repeated this experiment by setting a sensitive plant in a rocking motion for a quarter of an hour, during which the leaves closed, but after a further quarter-hour opened again. Upon the conclusion of this experiment the leaves remained motionless for a good hour. Then all at once the leaves began to droop, and when they raised themselves again, irritability had been restored within them. In Dionaea muscipula this habituation does not appear to take place, since the leaf-lobes do not open so long as the captured insect remains between them. Morren observed in the irritable stigma of Goldfussia anisophylla that when the plant was brought from a warm greenhouse (25 degrees R.) into a cool room (2 to 10 degrees R.), the irritability appeared to vanish entirely for a considerable time; but after twelve to forty-eight hours the plant had so accustomed itself to the cooler surroundings that the same degree of irritability was exhibited as in the warmth.

5) The degree of irritability in animals depends in part upon their state of health, increasing — setting aside certain

nervous diseases — with their vital vigour, while age, sexual condition, season, weather, and other external circumstances also exert a great influence upon it. And once again, precisely the same is true of irritable plants.

Hegel (Naturphilosophie, p. 480), in order to avoid interpreting the irritable movements of plants as indicative of feeling, states: "The externality of the causes of this irritability is demonstrated above all by the observations of Medicus, that several plants of the colder latitudes are not at all irritable in the afternoon or in hot, dry weather, whereas they are highly irritable in the morning after heavy dew and throughout the whole day in gentle rain; that plants of the warmer climates display their irritability only under clear skies; and that all plants are most irritable when the pollen is just ripening and the pistil becomes covered with a glistening oil." — I confess, however, that I cannot readily perceive how evidence against any significance of plant irritable movements for feeling or sensation is to be found in all of this; for in every one of these particulars, the irritability of plants is only analogous to the irritability of animals — particularly of the lower orders — which is most certainly connected with sensation. One need only recall, for example, the differing behaviour of frog preparations according to season and other circumstances in galvanic experiments.

One might feel tempted to derive objections against the psychical significance of plant irritable movements from the fact that they too openly bear the character of physical necessity, and that they occur even in severed plant parts — for example, in cut branches of the sensitive plant, in cut stigmas of

Mimulus — were it not that here too, apart from what has already been said in addressing the former objection, we find only analogies with the irritable movements of animals, which are most certainly connected with sensation. An unforeseen ray of light or the prick of a needle compels our eyes and our limbs to flinch and to feel just as surely as the needle-point compels the barberry stamen. Will, where it comes into play, can indeed suppress that movement, but it produces neither the movement nor the sensation.

In small children, where genuine will has not yet come into force at all, irritable movements take on altogether the character of involuntary movements. And plants behave in other respects as well in close analogy to children (cf. XV). "Upon light rubbing of the back of the hand, small children immediately extend their fingers; upon rubbing the back of the forearm, they extend the arm; and upon the same procedure applied to the shin, the leg; whereas tickling of the palm of the hand produces an immediate curling of the fingers." (V. d. Kolk in Fror. and Schleiden's Not. Oct. 1847. No. 75. p. 135.)

The irritable movements in severed plant parts, on the other hand, are only analogous to the irritable movements that may also be observed in severed frogs' legs, salamanders' tails, and the like. If one assumes, of course, that no sensation any longer prevails in severed animal parts themselves, one might turn this against our argument by saying that irritable movements, if they can occur at all without sensation, cannot be indicative of sensation in general. And indeed, irritable movements in pieces of plants will give as little indica-

tion of sensation in those pieces as is the case with pieces of animals; but then, by the same token, they will assuredly indicate as much sensation in whole plants as is the case in whole animals. One must simply refrain from making crooked comparisons. We do not assert that the irritable movement in itself constitutes sensation, but only that, within the coherent organism, it serves sensation or a drive standing in relation thereto. The mechanism for this may then indeed persist even in the severed parts.

Irritable movements in stamens.

In addition to the common barberry bush, irritability of the stamens has been observed in the North American barberry species with pinnate leaves, Berberis humilis and canadensis (Mahonia Nutt.); but not in other Berberidaceae, such as Epimedium, Leontice, and Nandina; — in certain plants of the Cactus and Cistus families, specifically Opuntia vulgaris, ficus indica, and tuna D.C. (Cactus opuntia, ficus indica, tuna), and according to Medicus also in Cereus grandiflorus hexagonus and peruvianus, a finding which Treviranus was unable to confirm; furthermore Cistus helianthemum, apenninum, and ledifolium (Helianthemum vulgare, apenninum, and ledifolium); in the hermaphrodite flowers of certain Centaurea species, notably Centaurea spinosa, ragusina, cineraria, glastifolia, eriophora, salmantica, Isnardi, and pulchella Led. (in the last of these Treviranus found the result particularly striking); — and finally in Sparmannia africana (a Tiliaceae). Concerning various altogether interesting phenomena in the stamens of different plants which, however, depend not upon irritability, to which they have indeed been

attributed, but rather upon mechanical or other causes (in Parietaria, Chenopodium, Atriplex, Spinacia, Urtica, Humulus, Morus, Forskalea, Genista, Spartium, Indigofera, Medicago, Kalmia, and others), cf. Treviranus, Physiol. II. 739. (Against Nasse's experiments on Parietaria and Urtica in particular, cf. Wiegm. Arch. 1836. II. 100.)

The stamens of the common barberry bush may still be set in motion even when their upper portion has been cut away, or when the pistil, the sepals, and the petals have been removed from the flower. If one prevents them, at the very moment of stimulation, from expressing their movement, they subsequently remain unchanged in their original position.

In the plants of the Cactus and Cistus families, irritability manifests in such a manner that, when one strokes across the filaments with a straw or the barb of a feather, or blows upon them, they perform a slowly turning and curving movement, which always proceeds in the opposite direction from that imparted by the impulse. This movement is the more lively the warmer the atmosphere is, up to a certain degree, but it does not possess the same rapidity as in Berberis, nor is it brought about by mere vibration alone. — The irritability of the Centaureas is most lively in those disc-florets which have only just opened. The filaments here contract upon contact with the anthers; not always immediately, but only one or several seconds after the contact has occurred, and they return after some time, though entirely gradually, to their former position, whereupon stimulation may be successfully repeated. Here too, warmth of the air favours irritability. (Treviranus, Physiol.)

Morren distinguishes more precisely five movements in the flowers of the Centaureae: "1) When one touches the florets lightly before the stigmas emerge, they perform a movement toward the centre of the composite flower and back again. 2) There follows a discharge of pollen. 3) The stigmas press forward. 4) If one now touches the flowers or the stigmas lightly, they perform a rotary movement. 5) If, finally, one stimulates the stigmas, the anther-tube draws itself downward and then rises again. The first movement originates from a contraction of the inner filaments of the stamens, which are grown fast to the floret and draw the floret along with the pistil. The second and third are produced by the continuing growth of the style; the fourth is likewise a consequence of the contraction of the adherent filaments, which proceeds in succession, and so too is the fifth. In all these cases, therefore, it is the filaments which, by their irritability, bring forth the movements." (Wiegm. Arch. 1844. II. p. 128.)

Irritable movements of the pistil.

Irritable movements confined to the stigma of the pistil have been observed chiefly in several genera of the Personatae family possessing a two-lipped stigma, of which mention was made above (Martynia annua, Bignonia radicans, and the genera Gratiola and Mimulus, in most of their species) with a brief description of the phenomena. Medicus claims to have noticed this irritability also in the two-lipped stigma of Lobelia syphilitica, crinoides, and crinus, for which observation, as he himself confesses, a more than ordinary degree of attentiveness is required. Beyond these, irritable movements

have been observed in the stigma of Goldfussia anisophylla and Goodenia, in the genital column of Stylidium, and in the hood-shaped appendages at the ovary of Pinus larix (the larch). In every case this irritability appears to stand in relation to the act of fertilisation. In the two-lipped stigmas of the Personatae this is so insofar as pollen, upon reaching the stigma, causes it to close and retains it therein; whereby, according to Don's view, the pressure upon the liquid contents of the pollen, as it grows into a tube, is supposed to contribute to driving that contents downward to the ovule (?).

Concerning the irritability of the stigma of Mimulus, Gärtner has recently conducted particularly careful experiments. (Gärtner, Versuche und Beobachtungen über die Befruchtungsorgane in den vollkommenen Gewächsen. Stuttgart. 1844.) When excised and kept in moist sand it behaved identically to the unexcised state. Vibration has no effect upon it, but chemical stimuli do, such as sulphuric acid. By means of oil of morphine or oil of strychnine (a mixture of morphine or strychnine with oil), the irritability is weakened and ultimately destroyed. Castration had no further influence upon the irritability, other than that it prolonged the duration of the flower and thus also of the stigma. An effect of the plant's own pollen upon the irritability occurs only during the period of receptivity; chemical stimuli, however, operate outside this period as well.

In Goldfussia anisophylla (formerly Ruellia anisophylla), when the flower opens, the tip of the style — which has the form of a pointed wire bent at the top into a hook — is seen curved beyond the stamens, so that the stigma, which ex-

tends along one side of the style for a certain length from the tip, is directed convexly toward the sky, while the concavity of the hook is turned toward the stamens. But if anything touches the style, or one blows upon it, or shakes the plant, or rapidly brings it from warm air (25° R.) into cold (-2° R.), the curved tip of the style straightens itself entirely upright, sometimes as straight as an arrow, sometimes somewhat curved like a flambard; occasionally (though rarely) the style also displays a lateral movement, to the right or left, forward or backward. Indeed, in great heat, the stimulated style curves in an arc toward the opposite side, so that the style with its stigmatic surface comes to rest almost directly upon the corolla. A full quarter of an hour or more may pass before it returns to its freely-assumed original position. The experiment may be repeated many times. The sensitivity of the style does not begin before the opening of the anthers, and endures until the flower has faded. It manifests in cut flowers, indeed even in isolated styles, just as well as in those still attached to the plant; brightness or darkness makes no difference to the success of the experiment. The purpose of the irritable movement is evidently the accomplishment of pollination, as will be discussed more fully below (XI). No spontaneous movement could be detected. (Nouv. Mém. de l'Acad. de Bruxelles. 1839.)

In the genus Stylidium, whose irritable movements were briefly noted above, the column — which terminates in two anthers and the stigma, and is to be regarded as the fusion of two filaments enclosing a style — has a double S-shaped curvature and, in its natural state, is bent downward along the

lower side of the flower's margin. Morren's investigations of Stylidium graminifolium yielded the following particulars: the movement of the little column takes place solely by virtue of the mobility of the curvature at its base. In the bud stage, irritability is not yet in evidence; it does not begin before the opening of the anthers, and manifests with full force only when they have begun to fold back to the sides, which they do during the period of fertilisation. When the anther apparatus has withered, the irritability ceases. As a rule the movement follows only upon stimulation; yet on very hot days, particularly toward midday, Morren also observed repeatedly that the little column would raise itself spontaneously (slowly, in approximately half a minute, whereas in response to stimulation it moves very rapidly) and would also return of its own accord to its former position. Once the column has been raised, any attempt to restore it to its lowered state is in vain; it springs back up by its own elasticity. The irritability persists unchanged in excised columns, indeed even in the curved piece at the base when cut out from the column itself. (Nouv. Mém. de l'Acad. de Brux. 1838.)

Concerning the irritability of the hood-shaped appendages situated at the base of the ovaries of the larch (Pinus larix) — held by Don, it seems incorrectly, to be stigmas — Don reports as follows: "I took a branch with unfertilised flowers, shook the pollen from the male catkins of another branch over them, thereupon found the stigmas filled completely with pollen, and could now readily observe how the walls of the stigma gradually contracted to complete closure; which manifestly serves to press upon the liquid contents of the

pollen vesicles and to drive them through the narrow passage to the ovule. After fertilisation has occurred, the walls of the stigma expand again; shortly thereafter it withers and is now found filled with the empty pollen vesicles. If one cuts a branch bearing female flowers before fertilisation, one is astonished to see how long the stigma remains open and in perfect condition." (Ann. des sc. nat. 1828. XIII. 83.)

Irritable movements of other floral parts.

In the genus Leeuwenhoekia — likewise Australian and belonging to the same natural family as Stylidium — the joint by which the fifth lobe of the corolla articulates with its tube is irritable, so that on being touched or otherwise stimulated, it quits its natural drooping position, raises itself quickly, and covers the immovable genital column with its hollowed blade. In the genus Caleya the lip also appears to possess some degree of irritability, as does that of several species of Pterostylis and of Megaclinium falcatum Lindl. In several species of Mesembryanthemum, the petals erect themselves when a drop of water is placed upon the stamens. In Bellis perennis a sudden erection of the ray florets can likewise be produced, though only after the stronger impression of ether. The bell-shaped flower of Ipomoea sensitiva closes immediately by infolding upon the slightest touch of its veins, according to Turpin. In Oenothera tetraptera, Hedwig observed a sudden withering of the corolla, which was on the point of opening, when he had carefully slit open with a small knife the calycine portion still enclosing it.

Irritable movements in leaves.

Of plants with simple irritable leaves, only Dionaea muscipula is known at present. Plants with compound irritable leaves occur, so far as is presently known, only among the Oxalidaceae and Leguminosae. Of the thirty-three to thirty-six plants belonging to this group that are known, only the movement phenomena of Oxalis sensitiva, Averrhoa carambola, and most carefully those of Mimosa pudica, or the sensitive plant, have hitherto been more closely examined. In some, the irritability is merely sluggish. The following is a list of those known to date:

I. Oxalidaceae: Averrhoa Bilimbi L., A. carambola L., Oxalis sensitiva L., O. stricta, O. acetosella, O. corniculata, O. purpurea, O. carnosa, O. Deppei (the latter six after Morren). — II. Leguminosae: Aspalathus persica Burm. — Nauclea pudica Desc. — Aeschynomene sensitiva Swartz, A. indica L., A. pumila L. — Smithia sensitiva Ait. — Mimosa casta L., M. peruambucana L. (Desmanthus diffusus Willd.), M. asperata L., M. pigra L., M. quadrivalvis L. (Schrankia aculeata Willd.), M. pudica L., M. sensitiva L., M. viva L. Willd. — Desmanthus lacustris Dec., D. natans Willd., D. stolonifer Dec., D. triquetris Dec., D. plenus Willd., D. polyphyllus Willd. — Acacia acanthocarpa Willd. To these are to be added, after Schreber, two not precisely determined species of Aeschynomene, and after Decandolle an Acacia from Senegal. (Wiegm. Arch. 1838. I. 347. 1840. II. 162.) — According to Mohl, in Robinia pseudacacia, viscosa, and hispida as well, the leaflets close to some degree upon shaking of the branches. He believes that this irritability of plant tissue is more general than was previously supposed. (Botan. Zeit. 1832. II. 497.)

In general, all known plants with irritable leaves favour the most humid localities; some, such as the species of Desmanthus, are outright aquatic plants. All, with the exception of Dionaea, which occurs in the warmer regions of the temperate zone, belong to the torrid zone. Most are herbaceous plants, few are shrubs or trees. All stimuli acting upon irritable leaves produce only a closing, never an opening. In compound irritable leaves, the same movements that may be caused by stimuli also occur spontaneously during the sleeping state.

Dionaea muscipula occurs sparsely in the swamps of North America. The leaves lie spread out in rosette form around the flower-stalk upon the ground, and bear at their forward end a rounded, reddish-coloured appendage, divided by an incision at its tip into two semi-oval lobes, connected to the rest of the leaf almost solely by the midrib. This appendage is densely set with small, somewhat fleshy glands; furthermore, the lobes are furnished not only at their margins with bristly cilia, but each of them bears also in the centre of its surface three erect and very small spines. The surface of the lobes secretes from the glands a juice which attracts insects, some of which appear to be greatly drawn to it. Yet scarcely has an insect alighted upon the ordinarily outspread leaf-appendages or lobes of the Dionaea than these snap together upwards within a few seconds; the cilia of their margins interlock with one another, and the spines assist in holding the little creature fast. The more the insect struggles, the more firmly the lobes close upon each other; only when it remains motionless do they open again, setting it free, provided

it has not in the meantime perished. The same effect produced by the stimulus of an insect is equally brought about by contact with a finger, a straw, or the leaves of neighbouring plants. Curtis found on occasion that the captured fly was enveloped in a mucilaginous substance which appeared to act upon it as a dissolving agent, whence he conjectured that the captured insect serves for the nourishment of the plant. The irritability of the plant stands in relation to the temperature of the air. Something similar to what is observed in Dionaea has been claimed for Drosera rotundifolia and longifolia as well, though with far slower movements; yet other observers were unable to confirm this phenomenon in the latter case.

Oxalis sensitiva is common in Amboina and other parts of India. The abruptly pinnate leaves of this plant, numbering approximately twelve pairs of ovate leaflets, fold together upon being touched or upon a few grains of sand being scattered upon them, in such a manner that the lower surfaces of both sides are brought into contact, after which, when the stimulus ceases, they gradually erect themselves again after some time. They close even when one approaches the plant and causes the ground to tremble. At night and on rainy days they are likewise closed. In the morning they are in a state of greatest erection and are not so susceptible to mechanical stimuli as at midday, when they fold together at the mere breath of air directed upon them.

Averrhoa carambola is a tree cultivated in Bengal, on the Moluccas, and in the Philippines for the sake of its fruit. The irritability of the pinnate leaves is here of a more sluggish character, so that it commonly does not manifest until several

minutes after the stimulus. The leaflets sink downward when the leaf-stalk is touched, so that those from opposite sides nearly come into contact with one another by their lower surfaces.

Mimosa pudica, the sensitive plant, with doubly pinnate leaves. The leaflets, the leaf-ribs, the main leaf-stalk, and even the branch, each possess their own particular movement, which may occur equally as a consequence of the ordinary sleep of plants as it may arise in response to stimuli. The movement of the leaflets consists in their folding forwards over one another in the manner of tiles upon a roof; that of the leaf-ribs, in their drawing near to one another; that of the leaf-stalk, in its laying itself back against the stem; and that of the branches, in their inclining at the tip. In this state of contraction the plant finds itself of its own accord at midnight; in the state of highest expansion, on the other hand, when all parts are remote from one another, it is to be observed on hot summer days in the forenoon in bright sunlight. Each of the aforesaid movements may, it is true, occur in consequence of stimuli without the others, yet this applies chiefly to the movement of the leaflets and leaf-ribs, since the leaf-stalks rarely move without drawing the former into activity along with them. From the part directly and mechanically stimulated the contraction proceeds outward, propagating itself to a greater or smaller number of further parts, according to the strength of the stimulation. The time which a leaf requires in order to restore itself to the state of expansion ranges from less than ten minutes to a quarter of an hour; this opening does not proceed with such regular succession of the parts as

does the closing. The seat of irritability lies principally in the joint by which each leaflet is connected to the leaf-rib, each of the leaf-ribs to the main leaf-stalk, and this to the branch; a gentle touch upon the joint, and particularly upon a white point at the articulation of each leaflet with the leaf-rib, suffices to produce the effect; contact with the leaves, by contrast, brings about contraction only insofar as it is accompanied by a vibration which propagates itself to the joints.

Severed branches, especially when the cut surface is placed in water, retain their irritability. Even during the nocturnal sleep the plant remains irritable; it opens and closes even under water, though more slowly. In the open air and by day, however, it moves most briskly, and the more so, the more vigorous it is and the higher the temperature of the air.

That the seed-lobes of the germinating M. pudica are already irritable, as Decandolle maintained, was not confirmed by Dassen; moreover, young leaves, before they have assumed the dark-green colour of the older ones, possess little motility. Yellowed leaves are not very irritable, though this is less noticeable when mechanical stimuli are applied than when chemical ones are used (Dassen). With the development of new leaves and during flowering, the motility in the immediately adjacent leaves diminishes noticeably; upon the ripening of the fruit the movements cease altogether.

Applied stimuli frequently extend their effects far beyond the point of their application, which is particularly evident when a leaflet is gently burned; for the leaves fold together far beyond the reach of the warmth itself. This propagation of the effect requires time, since the leaves more remote from

the stimulus fold together later than those closer to it. According to Dutrochet, the velocity of propagation in the leaf-stalks amounts to eight to fifteen millimetres per second, in the stem at most two to three millimetres; according to Dassen, however, no such precise determination is possible.

Concerning the manifold stimuli to which the sensitive plant responds, see above. The influence of one and the same stimulus, however, varies in degree according to the differing condition of the sensitive plant, hence the frequently divergent accounts of observers. Mechanical stimuli through wounding produce (according to Dassen) no movement, unless they are accompanied by loss of sap or by concussion, as one may often observe movement arising when a leaf is cut into, yet not when this is done carefully with a sharp pair of scissors. As effective chemical stimuli there have been recognised, among others: chlorine, ammonia solution, nitrous acid, sulphurous acid, sulphuric ether, and essential oils, whether applied in the form of vapour or liquid to the leaves of Mimosa pudica. These may extend their action to a very considerable distance. Thus, by carefully applying a strong acid to a single leaflet without causing any concussion, one may bring about the closing of all the neighbouring leaves. Camphor destroys the sensitivity and kills the plant, without the leaves closing. — Burning by fire is one of the most powerful stimuli. Dassen employed for this purpose, as particularly convenient, thin threads of cotton saturated with wax. With the very small flame they produced he was able to set young leaves in motion which could not be moved by any other means. Upon the sudden introduction of a cold below

freezing point to a branch of the sensitive plant, du Fay and Duhamel observed it first to open more widely than before with its leaflets, then to close very rapidly, and to open once again. — Galvanism appears, owing to the poor conductivity of the plant, to act only with difficulty, so that observers contradict one another on this point.

If the roots are burnt with concentrated sulphuric acid or a flame, not the slightest movement arises in the leaves (Dassen); yet it does arise when dilute sulphuric acid is applied (Dutrochet), where absorption is still possible.

Everything that is injurious to the life of the plant — such as submerging it in water, coating the leaves with oil or spirit of wine, the rarefied air of an air-pump, an atmosphere either too cold or too warm, prolonged deprivation of air, poisons of various kinds, carbonic, nitric, and nitrogen gas — likewise weakens or destroys irritability. By poisons the Mimosa is killed before the leaves are reached by the poison, and "thus one may," says Dassen, "explain its effect only through its action upon the whole plant, which differs according to the nature of the poison, since with narcotic poisons the limbs become slack, while with corrosive poisons they become rigid." Throughout all of this, one observes that the natural movements, those of sleeping and waking, disappear later than the movements produced by irritation. (Cf. from more recent experiments on Mim. pudica: Meyen in S. Physiologie III. 473; Dassen in Wiegm. Arch. 1838. I. 349; Miquel in Fror, N. Not. no. 9 of Vol. X. Göppert in Pogg. Ann. 1828. XIV. 252.)

X. Teleological Counterarguments

X. Teleologische Gegengründe.

We have earlier adduced various teleological considerations in favour of the plant soul. Yet one will at last suppose all these considerations overthrown by the simple counter-argument that the plant serves other purposes far too evidently and completely for it to be properly speaking an end in itself.

Let us first allow this objection to unfold with its full weight.

The structure, the constitution, the life and death of plants are entirely absorbed in purposive relations to the animal and human kingdoms, and these are wholly dependent upon them. Without plants, everything would starve, everything would perish in helplessness; man would have neither bread, nor potatoes, nor linen, nor wood; and therefore no house, no ship, no cask, no fire; and therefore no warmth in winter, no heat for the pot, no flame for the metals; and therefore no axe, no plough, no knife, no money. Without the plant, he would have not even flesh, nor milk, nor wool, nor silk, nor feather, nor leather, nor tallow, nor lard — for whence does the animal itself first obtain these things? And without all of this, he would likewise have no trade, no craft, no art, no writing, no books, no science; in short, he would have nothing but naked life, and before long not even that.

Man requires plants, then, and for this use they were created; and what man does not require, the animal requires,

which is itself in turn partly used by man, though it too has its own purposes. Every plant that does not directly serve man will certainly furnish food and shelter to one or more animals; and even in its decay, each plant nourishes millions of infusoria. The plant fulfils sufficient purpose in accomplishing all of this, and from this it is adequately explained why it exists at all. The entire infinite diversity of the plant world and its products means nothing other than this: to prepare for, or directly to satisfy, the equally great diversity of specially constituted needs within the human and animal kingdoms.

At times we observe many varied, often intersecting, useful services imposed upon a single plant for the benefit of animals and men; at other times a plant seems wholly designed for one principal service to man or beast. Both, however, demonstrate equally that the vocation of the plant can only consist in being entirely subsumed within purposive service to others. Often upon one and the same plant: the root for the worm, the leaf for the caterpillar, the flower for the butterfly, fragrance and colour for man, the fruit for his palate and stomach, the foliage still for his livestock. No fewer than seventy distinct species of insects are said to live upon and from the oak alone. In addition, the bird sings in its branches and the squirrel climbs among them; the pig gathers up the fallen fruits, the dormouse seeks shelter beneath its roots, man tans leather with its bark, hews from its trunk the keel of his ships and the beams of his house, and warms himself indoors at its burning branches. So entirely does this single tree dissolve, as it were, into purposive service for others. On the other hand, let one consider flax, the vine, the hop, and

so many medicinal plants — how entirely specially they are calculated for one particular principal purpose, to the benefit of man. Indeed, even the idle pleasure of man stands high enough that the structure and life of particular plants are expressly subordinated to its satisfaction. Because nature created women vain, she also created a plant for the particular service of this vanity. The mulberry plant, being what it is, had to be composed as it is so that silk might be spun from it; and that this purpose is truly its very concern is proven by the silkworm, assigned solely to its destruction, and rewarded for this with a foretaste of sensation. Tea and coffee would surely not contain such curiously compounded substances within them if man had not had equally curious cravings for them implanted in his nature. And everywhere, once the plant has prepared and produced what it is to furnish to men or animals, it is destroyed without mercy: the grain is promptly mown, the potatoes torn out, the tree felled, the flax steeped. Nowhere does nature appear to grieve for a plant when the purpose is to fulfil through it some end for men and animals.

After all this, only one interpretation of the relationship between the animal and plant kingdoms can seem possible. Man and animal were destined to bring soul, idea, and purpose into nature; this, to be sure, required matter as its vehicle and means of realisation. But lest the ideal remain too entangled in the material, too burdened by it, the far greater portion of the material provision and labour necessary to the purposes of the ideal was deposited in a separate world, wherein the material burden and toil is borne lightly, because it is not felt there. Were man and animal compelled to pre-

pare from the very beginning, by their own organs and their own exertion, all that is purely earthly and material which is already delivered to them ready-prepared by the plants, then no upward glance toward the higher might ever develop freely in man, and even the animal's free ranging across the earth would be stunted. As it is, however, man and animal partly enjoy with pleasure at once what they would otherwise have to create laboriously, and partly only the final fashioning remains to be applied to what is received already prepared from the hands of the plant; and in this they find at the same time the most favourable conditions for the exercise of their ideal faculty.

The entire existence of the human and animal kingdoms thus appears supported upon that of the plant kingdom as upon a foundation; yet one cannot demand of the bearer that it itself also contain within itself the higher thing which it is destined to raise above itself into a freer, more effortless existence — that is to say, here: the soul. Shall the candlestick also shine while it bears the light? Indeed, after the plant has shown itself wholly and entirely subordinated to the purposes of ensouled beings, would it not be to demand at once a superfluity and an impossibility that it should also have purposes of its own? Must it not rather be, for the plant as for the animal and human world, precisely the most favourable arrangement possible, that it should not even know the worth of a life, should not even come to suspect the joy of a life, which after all was destined only to be consumed in sacrifice for others? Being what it is, it surrenders itself without resistance to the purposes it is destined to fulfil, and serves pre-

cisely thereby most excellently in their fulfilment; and neither nature nor we need feel sorrow at putting it to such use.

I have allowed this objection so much room to develop because in so doing a truly wonderfully beautiful and great aspect of nature unfolds: the extraordinarily precise, careful, and most particular purposive arrangement of one organic kingdom for the benefit of the other. Yet it is, after all, only one aspect; and herein lies the inadequacy of the objection, and herewith it causes us to forget and to lose a wonder surpassing that very wonder. For the greatest wonder of nature consists precisely in this: that each of its beings, in every domain, while appearing to be made entirely for other beings, remains at the same time wholly directed toward its own ends; each ever serves the other, though in a different relation than that in which another in turn serves it; and all is so finely balanced and interlocked that the whole subsists in durability and vitality. Let us therefore grant that the plant is ever so carefully constructed and arranged to fulfil purposes for men and animals, indeed wholly and entirely calculated for such fulfilment — what of it? The entire presupposition is radically false, as though this were incompatible with an equally careful, fully precise calculation of the plant's structure and constitution for its own purposes. Every glance at the chain of natural beings, one that does not deliberately confine itself in one-sided contemplation, suffices to show this interconnection of purposes.

Menschen und Tiere ist, der die Pflanzen baut; genauer zu reden, die Kohlensäure, die Menschen und Tiere ausatmen, und Pflanzen einatmen; denn aus der Kohlensäure, die aus

dem Boden und der Luft den Pflanzen zukommt, bauen sie sich vorzüglich selbst. Nun ist Kohlensäure so gewiß ein Auswurfsprodukt des tierischen Lebens, als der Dünger und das Aas; ja noch unmittelbarer und allgemeiner, da auch die Fische sie ausatmen. Man hat hiernach in der Tat so viel Recht zu sagen, daß die Pflanze das Tier einatmet, als daß das Tier die Pflanze einatmet; denn das Tier atmet den Sauerstoff ein, den die Pflanze aus der Kohlensäure scheidet; die Pflanze atmet die Kohlensäure ein, die das Tier abscheidet; also lebt jedes vom anderen, wie das Herz von der Lunge und die Lunge vom Herzen. Aber die Pflanze atmet dabei das ein, was auch der Mensch nicht mehr haben will, was er schon verbraucht und verworfen hat, so wenig anmutig dieses auch klingt; denn eben in diesem Ausgeworfenen liegt das Wertvolle für die Pflanze. Das Tier hat es eben zuerst in seinen Dienst genommen, hat den Sauerstoff heraus genommen, und das übrige, was ihm nichts mehr gilt, der Pflanze gelassen, die es wiederum in ihren Dienst nimmt, den Kohlenstoff herausnimmt, und das übrige, was ihr nun nichts mehr gilt, dem Tiere läßt; so daß ein wahrer Haushalt zwischen Pflanze und Tier obwaltet.

Daß aber die Kohlensäure, die die Menschen und Tiere ausatmen, aus tierischer, bezügl. menschlicher Leibessubstanz entstanden, ist gar kein Zweifel. Was man ißt, geht in Fleisch, Blut, Knochen, Geist des Essendem über; das Fleisch, Blut, und Knochen und Geist, die mit der Lebenstätigkeit sich aufzehren, verwandeln sich zum guten Teile in Kohlensäure und gehen so in die Pflanze über, die also wirklich Fleisch, Blut, Knochen, Geist von uns trinkt.

Wenn man bedenkt, wie viel Fleisch, Blut, Knochen, Geist zur Mutter des Menschen und Tieres eingehen, so wird man sich nicht mehr wundern, wenn das Gewächs der Erde so prächtig aufblühet.

Alle Pflanzen in der Geschichte haben Menschen und Tiere, und Menschen und Tiere haben Pflanzen erzogen. Was es jetzt gibt in der Natur, ist ein Produkt dieser wechselseitigen Erziehung. Den seelenlosesten Pflanzen hat der Mensch jetzt, am Ende einer langen Geschichte, zu ihrer höchsten Entwicklung verholfen; er hat gezüchtet, was er nötig hat; aber das hat er so einrichten können, weil er eine Seele hat; Pflanz und Tier nach ihrem Sinne will man verständig; und der Mensch könnte wohl sagen, daß er im Ganzen doch der war, der dem Sinn und Sinne der Pflanze in der Geschichte am besten entsprochen hat. Wer nämlich bestimmt, was Disteln, Brennesseln, Bilsenkraut pflanzen? Den Menschen schädlich; aber den Tieren, denen es dient, nützlich; und diese Tiere dienten dem Menschen. Die Seele der Pflanze hat nun in dieser Geschichte bei weitem nicht die letzte Rolle gespielt; aber ihre Geschichte ist noch nicht zu Ende.

Die wechselseitige Ernährung und Erziehung von Mensch, Tier und Pflanze geschah und geht auf Erden nur in gewissen Grenzen vor sich. In diesen Grenzen hat sich ein wechselseitig passendes Verhältnis ausgebildet; alle drei zusammen bilden ein Ganzes, das sich selbst trägt und erhält. Wäre aber ein Teil dieses Ganzen seelenlos, dürfte man fast zweifeln, ob das Ganze eine Seele haben kann; und doch bedürfen wir einer Weltseele, einer Erdseele, einer Naturseele, so sehr als der seelenvolle Mensch selbst es bedarf.

Dog and cat must serve the pleasure or the convenience of man; but does this mean that they have less desire and striving within themselves? The cat devours the sparrow; but the sparrow does not exist solely for the cat; the sparrow devours the caterpillar, but the caterpillar does not exist solely for the sparrow; the caterpillar devours the plant; why then should the plant suddenly exist solely for the caterpillar and what lies behind it? I find nothing in nature that would forbid the delight which descends this ladder from descending further still into the blossoming plant; does the plant truly appear to be a step made of stone and iron? The plant serves other ends, it is true; justice therefore demands that other things in turn serve its ends; and nature exercises this justice, as will be shown more clearly hereafter. But then the plant must also be capable of having ends; and only a being possessed of a soul can have such ends — I do not mean ends in the sense of Hegelian categories of purpose, but even so only ends such as a being naturally has when it feels a drive toward something, and is well content when it attains that which it sought.

If a plant can render so much to so many others simultaneously, as we have seen in the example of the oak, then in this we are to find not so much a surplus of purposive fulfilment as the surest indication that its principal purpose has not yet been taken into consideration at all. For if it can render so much to so many others simultaneously, it is most natural to believe that it will above all be capable of rendering something to itself as well. But since it is itself the nearest to itself, it will also be able to render this to itself most fully and in the best coherence. The principal purpose, then, is to be

sought precisely in this. All those purposes which it fulfils for others are, after all, but scattered and fragmentary; they attach themselves to individual externalities, to offshoots of its life. Meanwhile the oak is something bound within itself, firm, whole, and unified, holding itself entirely together. And to this organically coherent field of activity, so entirely integrated within itself, should there correspond no correspondingly coherent field of purpose? Something would be wanting if the oak itself had no purposes to call its own. Who does not believe that if a star sends out rays in all directions, something corresponding and gathered must shine within it? Yet we allow the oak to send forth rays from a dark and lightless core.

If certain plants appear to be made solely to gratify petty, indeed faulty inclinations of mankind, this should at the very least demonstrate most clearly that what they appear to be made for can only be the least and most inessential part of what they are truly made for; or else our contemplation of nature becomes a very unworthy one.

If, however, one supposes that nature has wished to assign the greater part of material labour to soulless beings so as to relieve those possessed of souls, one should consider in opposition that, according to the general constitution of nature, material action is precisely that in which the activity of souls can express itself here below. Thus it would not be labour that is spared to the soul, but rather soul that would be spared for the labour, if the objection were correct — if that which could still have proceeded with soul were nonetheless to proceed without it. But to every labour and toil there will

also know how to attach itself a reward of labour, a recompense for toil. Even the king and the scholar must work with brain and pen; while the peasant and the craftsman work more with arm and plane. Yet the latter feels the exertion of his labour as well and as keenly as the former, and enjoys the reward of his labour equally well. Only in the one is feeling and enjoyment more refined and developed, in the other more coarse and simple, as accords with the labour and the material of the labour and of the labourer himself. But if the peasant can nourish the king and still feel what he does to nourish him, then the plant too will be able to nourish the animal and still feel what it does to nourish it. All the arguments by which a soul was denied to the plant kingdom in favour of the kingdom of humans and animals would in truth equally necessitate denying it to the peasant class in favour of the class of scholars and lords.

It is sometimes objected that our tools are also things that merely serve purposes without having purposes of their own — why should not plants be the same? But it is precisely the comparison with our tools which, as in earlier reflections, best serves to show that plants fall under an entirely different consideration.

Our tools do not live, weave, and grow of themselves as plants do; they have everything — their existence, form, and arrangement — from us, and therefore can claim nothing of purpose for themselves; the work that is done with them is not done by them — it is we who do it; and therefore only we can claim the reward of the labour. But plants, if they are tools, are self-living tools, tools that work within and with

and upon and out of themselves, as we do, and may therefore make similar claims to ours; they are instruments of God even as we are; yet in God's workshop no instrument has to serve another one-sidedly — each must serve every other in mutual reciprocity.

With this we come now to the second aspect of our subject, which the objection has entirely overlooked, or has regarded one-sidedly as swallowed up by the first, whereas it is in truth most beautifully entwined therewith. And with this the argument that was turned against the soul of plants will wholly turn in their favour.

Plants serve human beings and animals; but conversely, human beings and animals must serve the plants; and if the former were to render plants soulless, the latter ought equally to render human beings and animals soulless. It is only because we, accustomed as we are to measure all things by ourselves and our own needs, do not stand in service to the plants in the same manner as they serve us, that we do not regard it as service at all.

With the same right by which one says that humans and animals eat and devour the fruits of the field, one can in truth say that the fruits of the field eat and devour humans and animals in return; for everything that passes away from humans and animals passes again into the plants, and must pass into them so that they may grow and flourish. They only do not tear man apart while he yet lives, as we do with them. They wait for what departs from us, until it comes to them; they await our death before they take full possession of us. This patience is now interpreted as sluggish insensibility and dead

passivity; but wrongly, for that they are in truth not insensible to all of this they demonstrate precisely by the fact that when it does come to them they receive it eagerly and grow joyfully thereby. This patience is connected above all with their being bound to the soil and their, so to speak, feminine character in relation to animals. Even a queen waits for what she needs to be brought to her; she is of course assured that she need not wait long, for many hands are busy for her of their own accord. So the whole plant waits for the body of the animal to dissolve, in order to build its own body; the flower waits for the insect to come to it and assist in its fertilisation; the seed waits for the sower to take it up and cast it into the earth; and the insect and the human being will surely do so, though in the first instance for their own sake — but nature has so arranged insects and human beings that what is done for their own sake becomes at the same time something done for the plant's sake.

Should nature also set the plants to contend with the animals for what each needs from the other, when animals already do so much of this contending among themselves? She has preferred to let giving and taking interlock here in peace and concord, so that all things should not dissolve into discord. Thus she has permitted us to use plants at will for our own ends, without the plant being able even to defend itself; yet against our very will we must in turn serve the plants, and can we perhaps defend ourselves any better against this?

It is not dung and the decaying corpse alone that benefit the plants as nourishment from humans and animals. On the contrary, in a secret commerce unknown to most people, they

must render to plants the most important thing by means of the most important thing they themselves possess. Indeed, whence does one suppose that a plant, growing in a pot or out of doors, grows so large? The soil seems scarcely to diminish. Nor does a plant leave much ash behind when burned. Water taken up does much, to be sure, but a little earth and much water still does not by any means make a plant. However strange it may sound to some, it is certain that it is chiefly the breath of

human beings and animals that builds the plants; or more precisely, the carbonic acid that humans and animals breathe out, and plants breathe in; for it is primarily from the carbonic acid that reaches them from soil and air that plants construct themselves. Now carbonic acid is as surely a waste product of animal life as dung and carrion; indeed more immediately and universally so, since even fish breathe it out. One has accordingly, in truth, as much right to say that the plant breathes in the animal as that the animal breathes in the plant; for the animal breathes in the oxygen that the plant separates from carbonic acid; the plant breathes in the carbonic acid that the animal secretes; and so each lives from the other, as the heart from the lungs and the lungs from the heart. But the plant breathes in that which the human being no longer wishes to have, what has already been consumed and cast away — however little agreeable this may sound; for it is precisely in what has been cast away that the thing of value for the plant resides. The animal has first taken it into its own service, extracted the oxygen, and left the remainder, which is of no further value to it, to the plant, which in turn

takes it into its service, extracts the carbon, and leaves the remainder, which is now of no further value to it, back to the animal; so that a true economy prevails between plant and animal.

That the carbonic acid breathed out by humans and animals has arisen from animal, or more precisely human, bodily substance is beyond all doubt. What one eats passes into the flesh, blood, bone, and spirit of the one who eats; the flesh, blood, bone, and spirit consumed in the activity of life transform themselves in large part into carbonic acid and pass thus into the plant, which therefore truly drinks flesh, blood, bone, and spirit from us. When one considers how much flesh, blood, bone, and spirit flows into the mother of human being and animal, one will no longer wonder that the growth of the earth blossoms forth so magnificently.

All plants throughout history have cultivated humans and animals, and humans and animals have cultivated plants. What exists now in nature is a product of this mutual cultivation. Even the most seemingly soulless plants have been brought by man, at the end of a long history, to their highest development; he has cultivated what he requires; but he was able to accomplish this because he has a soul; to manage plant and animal according to their own nature, one must have understanding; and man might well say that on the whole it was he who, throughout history, best answered to the sense and sensibility of the plant. For who, after all, determines where thistles, nettles, and henbane grow? Harmful to humans, perhaps; but useful to the animals that feed upon them; and those animals served mankind. The soul of the

plant has played far from the least role in this history; but its history is not yet concluded.

The mutual nourishment and cultivation of human being, animal, and plant has taken place and continues to take place on earth only within certain limits. Within these limits a mutually fitting relationship has formed; all three together constitute a whole that sustains and maintains itself. But were one part of this whole without a soul, one might almost doubt whether the whole could have a soul; and yet we stand in need of a world-soul, an earth-soul, a soul of nature, as urgently as the soul-endowed human being himself requires it.

and animals is that from which the plant builds itself, that which creates its solid framework. Virtually all the solid matter that remains as charcoal when plants are burned is drawn by the plant from the carbonic acid of the air (and the water saturated with it) — the very same substance that escapes as the foam of champagne. This carbonic acid is exhaled by human beings and animals, taken up by the plants, its carbon separated out and transformed into their substance, while the oxygen (whose combination with carbon constitutes precisely the carbonic acid) is returned to the atmosphere.

"Assuredly," says Dumas, "the little patch of soil in which the acorn germinated centuries ago, from which the mighty tree now standing before us arose, did not contain a millionth part of the carbon that the oak now possesses. The remainder, that is to say the whole of it, has reached it from the air." (Dumas, Statik der organ. Ch.)

Boussingault found that the manure used on an estate for one hectare of soil contained only 2,793 kilograms of carbon,

whereas the harvest gathered from it amounted to 8,383 kilograms. On another estate, the harvest contained as much as 7,600 kilograms more carbon than the manure. The surplus must therefore have derived from the air.

The same investigator conducted an experiment in which peas laid in pure gravel-sand and watered with distilled water, obliged therefore to draw their nourishment solely from the air, nevertheless developed, bearing leaves and seeds. (Ibid.)

How eagerly the plants absorb the carbon from the air is demonstrated by the following experiment of Boussingault's. He found "that vine-leaves introduced into a flask absorbed all the carbonic acid contained in the air passed through it, however swiftly the current of air was allowed to stream through. Likewise, Boucherie observed carbonic acid escaping in prodigious quantities from the root-stocks of trees standing in full sap." (Ibid.)

In winter our breath congeals into flowers upon the windowpane; in summer the living flowers of the meadow shoot forth from it. God, it is said, breathed the soul into man; conversely, one may say, man breathes the body into the plants.

Human beings and animals must therefore breathe and live, in order that the plants may grow and live; indeed, the lungs of human beings and animals may be regarded as nothing less than organs whose purpose it is to prepare for the plants this most indispensable necessity of life. We keep cows to prepare milk for us in their udders; for the plants, God keeps human beings and animals to prepare carbonic acid for them in their lungs. The cow herself, as she grazes upon the grass, helps through her breath to build new grass; she con-

sumes only the old leaves, that is to say the products of the plants' earlier vital activity, and, as was noted before, what is already formed means comparatively little to the plants; in return she breathes out the material for new vital activity, for the transformation of that half-spiritual substance into bodily form constitutes the principal task of the life of plants — it is precisely this that makes them grow, puts forth greenness, and live. Might one not say here as well: nature has, so to speak, unloaded upon the animal the greater part of the material preparatory work on behalf of the plant — the entire process of grinding down and digesting the coarser substances — leaving to the plant only the beautiful, light, and cheerful task of building and adorning, ever anew, the most graceful and lovely body from that spirit-like substance which emerges as the final product of that coarse process; sculptor and painter in one, and not even required to stir from its place. Does not the ideal hover here entirely within the plant kingdom, while the gross foundation lies entirely within the animal kingdom?

To be sure, breath alone does not accomplish everything; the burning of wood also contributes greatly to the carbonic acid of the air; for what the plant drew from the spirits of nature during its life returns to them at the plant's death as a fiery exhalation — yet only for the growth of new plants, for the rejuvenation of the plant world. The whole plant must, after all, one day die. In this respect we may ascribe to human beings the significance of angels of death for the plants. We paint Death with his scythe; for them he walks in bodily form

with scythe and axe, a higher being, destructive to the individual, yet serving the renewal of the whole.

In drawing nourishment from the breath and the products of fire, the plant is of course at once called upon to render an equivalent service in return. Were it not to absorb the carbonic acid from the air, the latter would grow ever more corrupted, since carbonic acid, as the product of breathing or combustion, can no longer itself serve to kindle or sustain breathing or fire — on the contrary, both are suffocated where the air becomes too heavily laden with carbonic acid. But the plant, in stripping this gas of its carbon, regenerates from it the vital air, the oxygen, which originally served for breathing and combustion, and by restoring it to the atmosphere keeps that atmosphere perpetually fresh and vigorous for the sustenance of life and fire. Thus the plant world and the animal world complement one another in their purposive functions. The plant inhales the carbonic acid that the animal exhales, and the animal inhales the oxygen that the plant exhales; the plant decomposes the carbonic acid and appropriates from it the solid substance, the carbon, in order to build its body; the animal combines oxygen with the carbon of its own body and expels that combination in gaseous form, in order to rid itself of a spent substance. Yet both processes are necessary for the sustenance of the life of each.

After all of this, it will of course always remain possible to say: yes, in order that man might have wood, the tree must first grow and propagate itself; and in order that man might have bread, the grain must flower and bear fruit; and in order that man might always find the air pure for breathing, the

herb must put forth its greenness within it. But it will always be equally possible to invert this and to say: in order that the tree, the grain, and the herb might grow, turn green, flower, and bear fruit, man and animal must first produce the manure and the carbonic acid of the air; man must continually burn the old wood; man and animal must grow and nourish themselves in such a way as to perform all of this during their lives, and even in death to furnish such suitable products of decomposition for the plants. Now, it would of course strike everyone as the height of folly to believe in earnest that the beautiful and artful organisation of man and animal exists solely so that their waste, by-products, and products of destruction might benefit the plants; but do people not see that it is equally foolish to believe that the plants are so beautifully and artfully arranged and constructed merely in order that the waste, by-products, and products of destruction of this beautiful construction might in turn benefit the animals — especially since by far the greater part of their usefulness lies precisely in these products of destruction. In truth, however, this is the view with which we ordinarily content ourselves. The vine exists so that we may crush its grapes; the tree exists so that we may chop it into logs and thrust it into the stove; the cabbage exists so that the caterpillar may devour it and we may boil it. Or do we wish to lay great weight upon the aesthetic impression that the plants make upon us while still living? Plants do indeed gladden the eye of man by their greening and flowering while yet alive. But how many plants perish without ever making any impression at all upon a human eye; and before man appeared upon the earth, many

thousands of years had already passed during which plants grew upon it, whose greenness assuredly awakened no aesthetic feeling in the mammoths and cave bears. And for what else does one hereby declare the plants to be, if not adorned corpses or whitewashed sepulchres, when one assigns to their living outward appearance the further purpose of delighting us with external ornament, while their entire inner content is consecrated to nothing but destruction? This mode of contemplation appears to me so senseless that for its sake alone I should be inclined to hold the plant to be not without a soul; and our natural feeling is far from concurring in it, as has already been discussed on several occasions.

When man, in cultivating himself, supposes that the whole world had nothing further to do than to cooperate toward this end, he is, in a certain respect, quite right. But the rose, the dahlia, which in the course of this cultural development has grown from a rough and simple plant into a splendidly resplendent flower in a thousand varieties, has equally good reason to suppose that everything, and man himself, has revolved solely around her cultural development; without man, such beautiful abundance, such rich variety could never have come to be within her; man had to cultivate himself in order to cultivate her. The grain of the field may likewise be in the right when it supposes that everything was directed solely toward bringing it into its beautifully ordered society of ears; that man is merely a tool prepared by nature to guide the plough and till the soil for its benefit, so that in the smallest space the greatest number of ears might sustain themselves, undisturbed by foreign intruders. And indeed, is man

himself perhaps sown and tended by higher spirits just as the dahlia and the field of grain are tended by him; is not death the severing of a flower, a battle the mowing of a field?

I think that with man and beast and plant it is no different than with the sun, the earth, and the moon. The moon appears to be the most subordinate in significance within the planetary system, just as the plant appears within the system of our terrestrial organic world. But one who stands upon the moon sees the earth and the sun revolving around the moon, and perceives himself at the centre of the whole. One who stands upon the sun says: you are mistaken; you, together with the earth, revolve around me. Yet both are mistaken, or both are right, as one pleases. In truth each revolves around the other, depending upon whether one takes one's standpoint upon the one or the other; but from an absolute standpoint, neither revolves around the other any more than the other does, but rather all revolve around their common centre of gravity, which represents the totality of the entire system. Thus all life revolves around God; but God himself represents in his unity the life and movement of all his creatures. A centre of gravity is, after all, nothing without the force that draws all parts of the gravitating mass toward one another.

Many a man grounds his belief in the future immortality of the human soul upon the supposition that God would surely not have constructed the human body with such extraordinary art, and arranged it with such minute purposefulness, were it not in favour of an eternal soul; how singular, then, that one can suppose He has arranged the body of the

plant with equally great care and purposefulness in favour of no soul whatsoever.

XI. Examples from the Teleology of the Plant World

XI. Beispiele aus der Teleologie der Pflanzenwelt.

It is well known that the most essential condition of plant fertilisation consists in the transfer of pollen from the anthers — that is, the terminal parts of the stamens, or filaments — to the stigma, that is, the terminal part of the pistil. The anthers are, however, always situated at a certain distance from the stigma; and in many plants there exist besides particular circumstances which render the conveyance of pollen to the stigma yet more difficult. In order nevertheless to bring this about, nature has devised manifold and remarkable arrangements, among which the organisation of the instincts and manner of life of many insects plays a principal part. Wherever the business of fertilisation could not be adequately accomplished by the plant itself by virtue of the structure and position of its parts, insects are ready to render assistance, mediating the transfer of pollen from the stamens to the stigma by their movements within the flower. Not bees and butterflies alone, but also many beetles (of the genera Cetonia, Elater, Chrysomela, Curculio, and others), hemiptera, and neuroptera take part in this office.

In many flowers, several species of insects cooperate in effecting fertilisation — as, for example, in the Schirmblumen and the Euphorbias — but in many flowers this business is performed by one species of insect alone, "because," as Conr.

Sprengel expresses it, "the others are either too stupid to know where the nectar is concealed and how they may reach it, or, if they do know, are either too large to creep into the flower, or too small to touch the anthers and the stigma in doing so." Thus, according to Sprengel, Nigella arvensis is fertilised only by bees, and Iris xiphium only by bumblebees, each in a very particular manner. In Pennsylvania, moreover, a very small species of hummingbird, called the hummingbird moth, renders to the fertilisation of certain plants the same service as insects, feeding upon the nectar of flowers, into whose tubes it plunges its long and pointed beak to a great depth, flying to and fro from one flower to another. (Kalm, Travels in North America, II. 354.)

The following circumstances now interlock in a remarkable manner with respect to the fulfilment of this purpose.

To induce the insects to make their visits, nectaries, or honey-vessels, are provided for them; moreover, certain insects, such as bees, possess the instinct of gathering pollen for themselves. The flowers secrete the greatest quantity of honey precisely when their stamens and stigmas are in a condition fit for the work of pollination, as Schkuhr (Handbuch II. 84) has specifically observed in Tropaeolum, Delphinium, and Helleborus, and L. Ch. Treviranus (Physiologie II. 390) in Anemone, Chrysosplenium, and Saxifraga. The honey is commonly situated at the deepest and most concealed place within the flower, so that the insects cannot reach it without, in creeping in and out, touching the organs of fertilisation and conveying the pollen to the stigma. Small hairs of suitable disposition commonly protect the nectaries from rain, and

consequently from the dilution of their juice, without, however, barring the access of insects. A sticky consistency or fibrous texture of the pollen greatly favours its adhering to the bodies of insects. On the other side, one finds in insects that live upon flowers either a fur-like hairiness over the whole body, or brush-like mouthparts, brush-like or pencil-like tufts of hair upon the feet, or a peculiar organisation of certain parts, all serving the purpose of stripping off the pollen with greater ease. One need only consider, for instance, the hairy, robust body of bees and bumblebees and other bee-like insects, together with the vigour with which they move within the flowers. In the Nymphalis butterflies, which among the day-flying species visit flowers most frequently but do not linger long upon them, one finds, in place of developed forelegs, brush-shaped cleaning feet, whose active motion while the butterfly rests upon the flower readily has the effect of brushing away the pollen that clings to its hairy breast, so that it falls back upon the flower. Nor is it without design that bees, when they make their excursions, commonly visit but one species of flower at a time — a circumstance already noted by Aristotle and confirmed by more recent observers (Mitteilungen der k. k. schlesischen Gesellschaft, 1823, p. 174); for in this way pollen may readily be transferred even between different, yet, as is necessary for the purpose of fertilisation, conspecific plants.

As further supporting circumstances one may adduce that the peculiar colour of the flowers, and in part also their fragrance, combined with the developed visual organs of insects, facilitates the finding of the former by the latter. Frequently

the paths to the nectaries are yet more specifically indicated by particular colourations on the petals — so-called nectar-guides — that serve, as it were, as signposts. I am indeed scarcely of the opinion that this circumstance, and much else besides, carries as great a weight as Conr. Sprengel assigns to it in his work Das entdeckte Geheimnis der Natur; yet his presentation of this subject has its own interest, if only for the ardour with which he apprehends it.

He writes of it (p. 15 of his work) as follows: "When an insect, enticed by the beauty of the corolla or by the pleasant fragrance of a flower, has betaken itself thither, it will either perceive the nectar straightway, or not, because the latter is situated in a concealed place. In the latter case, nature comes to its aid by means of the nectar-guide. This consists of one or more spots, lines, dots, or figures of a colour different from that of the corolla in general, and consequently stands out against the colour of the corolla more or less strongly. It is situated always precisely where the insects must creep in if they wish to reach the nectar. Regular flowers have a regular, irregular flowers an irregular, nectar-guide. When the nectary is distant from the opening through which the insects creep, the nectar-guide, commencing before the opening, extends through it as far as the nectary, and thus serves the insects as a sure guide. If a flower has several entrances to the nectary, it has likewise as many nectar-guides. If a flower has several nectaries standing in a ring about the ovary, or indeed only one, but one which encircles the ovary in the form of a ring and whose nectar the insect cannot consume otherwise than by running in a circle about it and repeatedly inserting its

proboscis; then the nectar-guide is of a ring-like form, and leads the insect in a circle."

"On the occasion of discussing the nectar-guide, I must speak of the diversity of nectariferous flowers, which depends upon the time of day in which they bloom. Just as there are insects that swarm abroad only by day, and others that seek their nourishment only by night, so likewise there are day-flowers and night-flowers."

"The day-flowers open in the morning. Many of them close in the evening, or droop, having stood erect during the day, or undergo some other change, from which one may conclude that they are destined only for day-flying insects. Some close on the first evening and do not reopen on the following morning, blooming therefore for only a single day; the greater number bloom for several days."

"The day-flowers are adorned with a nectar-guide, though not all of them."

"The night-flowers open in the evening. During the day most of them are closed, or faded and inconspicuous, from which it is evident that they are not destined for day-flying insects. Some bloom for several nights; the common evening primrose (Oenothera biennis) blooms for two nights."

"The night-flowers possess a large and brightly coloured corolla, so that they may catch the eye of insects in the darkness of the night. If their corolla is inconspicuous, this deficiency is compensated by a powerful fragrance. A nectar-guide, on the other hand, does not occur among them. For if, for example, the white corolla of a night-flower were to bear a nectar-guide of a different, yet equally bright, colour, this

would not stand out against the colour of the corolla in the darkness of the night, and would consequently be without utility. But if it were to bear a dark-coloured nectar-guide, this would not catch the eye, and would thus be equally useless as the former."

Almost comically naïve appears the examination which the author conducts with himself concerning the purposive arrangements in Nigella arvensis (p. 285 f. of the work), wherein he seeks to interpret the smallest trifles teleologically. He asks, among other things: "Why, finally, is the flower precisely as large as it is, neither larger nor smaller?" Answer: "Because Nature wished that it should be fertilised solely by bees, and consequently had to take its measure, as it were, from the body of the bee. Were the flower twice as large in diameter, the anthers and stigmas would likewise stand twice as high, and the bees would wander beneath them without touching them. Were it but half as large, the anthers and stigmas would stand but half as high, and the bees would not touch them in any purposive manner. In both cases, therefore, fertilisation would be impossible or highly precarious. The flower had to be precisely so large that the bees can move about beneath the anthers and stigmas without quite, yet almost, doing so unimpeded. That Nature has destined these flowers solely for the bees and permits them to be fertilised by them alone is highly probable. I have frequently repaired to the field on which the plant grows, in fair weather, yet have never seen any insects upon the flowers save bees."

Of Stapelia hirsuta he says, at p. 148: "It stinks like carrion for no other reason than to attract the flesh-flies and carrion-

flies, to whom this odour is most delightful, so that they may visit and fertilise it. Bees and bumble-bees will certainly not visit it, for they abhor such a smell."

Here follow several particular observations concerning the purposive considerations taken in the positioning of nectaries, drawn from Reichenbach's little work on the preservation of the world (p. 27):

Let us consider the most simply formed honey-pits and honey-scales in the ranunculi; the flowers lie openly spread, and the access of insects is easy; but the pits themselves lie deep at the base of the petals, at the very point where the stamens bend over them. The ranunculi are attended by insects assigned from the order of beetles with half-wing-covers: the smallest staphylinids, anthophages, omalids, and furthermore the smallest butterflies in existence, from the family of moths — gold-gleaming Oecophoras and, in their miniature way, resplendent Adelas. While these small creatures seek out the honey-pits, they lift the stamens upward, so that the anthers touch the stigmas spread open in the centre; moreover, they remain within the flower even when it closes, and sit then directly upon the anthers and stigmas, often in such numbers that they fill the entire flower. In the umbellifers, the nectaries are of a glandular nature, not very concealed, and their flowers are arranged in a plane, so that many may be touched simultaneously by a moderately large body; hence somewhat larger insects are found here — long-legged lepturids, bees with hairy bodies, and bee-like beetles which, bristled over their entire body like a brush, act upon a large portion of the flowers of a single umbel at once; accordingly the petals are

small and lie flat, while the stigmas and anthers are long and project above the surface. But where the nectaries are more deeply concealed, the structure of the flowers is likewise suited to those insects whose bodies are to come into contact with them. Labiate flowers as well as tubular flowers have their honey-vessels likewise deep at the base, at the foot of their tube; the stamens are attached to its inner wall, and the anthers come to lie where the tube widens, so that it becomes possible for insects which are especially hairy at the fore part of their body to touch the nectaries with their tongue, whilst their fur-covered thorax sweeps the pollen from the anthers and, upon crawling out, deposits it upon the stigma, which is set higher for that very purpose. By this means it is likewise possible that even the bombyliids, which visit these kinds of flowers — the primroses, lungworts, dead-nettles, and the like — while hovering before the flower, without alighting upon it, and drawing out the honey, may nonetheless advance the work of fertilisation.

It is true that, as is otherwise the habit of Nature not to rely upon a single means alone, and among several means toward the same end to let now one, now another prevail, fertilisation in most plants is also possible, by virtue of other arrangements, without the assistance of insects; yet this assistance remains everywhere beneficial, and for certain plants, in which the chief weight is precisely laid upon this means, it is truly essential. Some foreign flowers therefore remain unfertilised among us, because they have come to us from the southern hemisphere and still observe, even in our hothouses, the season of their flowering which coincides with our

winter — a time when there are no insects to assist in their fertilisation. Some, again, may be fertilised in their native land by an insect which does not dwell in our regions. (C. Sprengel, Entd. Geh. p. 44.) Even with indigenous plants, observations of this kind may be made. Thus attentive gardeners note that in melon and cucumber beds which are kept closed, fruit does not readily set, because the insects are excluded and the heavy pollen cannot of its own accord reach the stigma. Even among the species of iris, the malvaceous plants, the elder (Sambucus), the violet (Viola odorata), the mistletoe, Abroma augustum, and the birthwort species (Aristolochia Clematitis and sipho), fertilisation is said to be possible only with the aid of insects. (Kölreuter, Vorläuf. Nachr. 21. 32. Zweite Forts. 70.) To this class belong especially, however, the Asclepiads and Orchids.

I share hereon the following account from Schleiden: "Particularly in the two great plant families, the Asclepiads, to which the Syrian silkweed belongs, and the Orchids, which adorn with their splendid, many-coloured butterfly-like and wondrously constructed insect-resembling flowers the warm and humid shadows of the tropical forests — in these two plant groups especially the decisive intervention of insects in the increase of plants is manifested. In them, the pollen of each anther is agglutinated by a substance resembling birdlime into a single mass, and clings so firmly to the nectar-seeking insects that they cannot cast it off. The honey-receptacles are arranged within the flowers in such a manner that the insect, in order to reach them, must necessarily brush close past the stigma, and thus the pollen is brought to its ap-

pointed place. One often sees flies crawling about upon the silkweed, trailing from their legs a great number of these club-shaped pollen-masses; and in certain districts beekeepers know of a peculiar malady afflicting their industrious little creatures, called the club-sickness, which consists in nothing other than that so many masses of orchid pollen have fastened themselves to the foreheads of the bees that flight becomes impossible for them, and they perish as a consequence." (Schleiden, Die Pflanze, p. 70.)

In certain flowers the process takes on an even more singularly remarkable character; as in the birthwort (Aristolochia Clematitis). Here the flower is a tube which is swollen below, narrower above at first, then widening again toward the bluntly tongue-shaped rim of the mouth, and which, prior to fertilisation, is lined on the inside with small hairs all directed downward. The anthers are seated without filaments beneath the ovary, and of themselves no pollen could pass from them to the stigma. According to Conrad Sprengel, however, as soon as the flower has opened, small gnats with feathered antennae (Tipula pennicornis) crawl into the floral tube; the downward-directed hairs bar their retreat. Thus they swarm about in the swollen portion of the tube until, with their feathered antennae, they have swept the pollen from the anthers and deposited it upon the stigma. They are often found quite powdered with it when the flowers are cut open betimes. Scarcely has fertilisation been accomplished when the sap ceases to press toward the corolla, the hairs wither and fall away, and the little flies are once more released from their captivity.

Let one seriously reflect upon this case: can one truly believe that sentient creatures are here imprisoned for the benefit of those devoid of sensation, to remain confined until they have fulfilled their purpose for the latter?

In the genus Eupomatia, all connection between the anthers and stigma is interrupted by the inner sterile, petal-like stamens, yet it is re-established through insects, which devour those sterile parts while leaving the perfect pollen-bearing stamens unharmed. (R. Brown, Verm. bot. Schr. I. 140.)

The arrangement of the irritable stamens of Berberis is unquestionably calculated so that, through the touch of insects or similar agencies, the stamens are induced to move toward the pistil. In a different manner, the irritable movement of the genital column of Stylidium, or of the style of Goldfussia — likewise readily provoked by insects — serves the same end (see above). In Stylidium, the anthers seated upon the genital column, upon reaching maturity, move away from the stigma rather than toward it, discharging their pollen onto certain hairs that grow abundantly at the summit of the column, but which, when the column is bent downward, find themselves positioned beneath the stigma. When the column is caused to spring upward by the touch of an insect or the like, not only may the pollen thus be readily flung from the hairs onto the stigma, but the hairs afterwards find themselves in a favourable position to allow the pollen to fall down upon the stigma from above. (Morren in Mém. de l'acad. de Brux. 1838.) In Goldfussia, the movement of the style serves to bring the stigma into contact with certain hairs of the corolla, upon which the pollen of the anthers — themselves un-

favourably positioned with respect to the stigma — falls partly of its own accord and is partly conveyed by insects. Morren frequently observed small ants penetrating these flowers, depositing pollen upon the hairs, and thereby causing the movement of the style (ibid. 1839, p. 17). The relationship between the irritable movement and the sexual function is made particularly evident in both plants by the fact that the irritability persists only during the period in which that function is active.

The same elevation of plants to a level with animals that we have observed in their mutual teleological relations is found again in the peculiar and purposive arrangements that plants possess for their own benefit. In this regard, provision is made for the preservation and propagation of plants in precisely the same manner as for that of animals. The very circumstance that animals play a role in the reproductive process of plants — serving, on the one hand, as an auxiliary, yet, on the other, as merely an auxiliary, one that may even under certain conditions recede very greatly into the background — points to the independent significance of this process for the plants themselves. Among the several means of fulfilling the aforementioned purpose, animals are simply one among others. And the other means directed toward the same end are in part arranged no less ingeniously than the assistance rendered by insects. Yet all of this would assume the character of an empty game, were one unwilling to grant the plant any significance beyond that of serving alien purposes.

To be sure, someone might object: does it not in every case remain an empty game? Is not all that we here call purposive

in reality nothing more than the partial remedy of a thoroughgoing purposelessness, which must have been all the greater the more artificial the means required to overcome it? Would it not have been simplest, and hence most expedient, if the pollination of the stigma of the pistil were once deemed necessary for fertilisation, to have allowed the pollen to grow directly upon the stigma or in its immediate vicinity, rather than placing it in separate anthers and frequently even multiplying the difficulties of its transference, only then to stand in need of special auxiliary contrivances in order to accomplish it nonetheless?

Whoever speaks thus demonstrates that he has grasped very poorly the spirit of the teleology of nature. One might with equal justice say: would it not have been simplest and most expedient for nature to cause apples to grow directly into our mouths, instead of first giving us hands with which to reach them from a distance; or to set finished houses before us, instead of endowing us with senses and understanding so that we might build them ourselves? Why did she leave us anything to do of our own accord? The answer is this: because it is precisely in the yearning and striving for all that is not simply cast before us ready-made that the soul expresses and ought to express itself in feeling and endeavour; and the more varied the things we must have without yet possessing them, the more manifold become the modes of feeling and striving open to the soul. It is through this consideration, and through it alone, that the manifold means which nature has employed — setting the purpose of fertilisation at a distance in plants, yet allowing it to be attained

through intermediate agencies — receive a rational interpretation; and at the same time these means become evidence for the operation of a soul within plants. For if no soul is active within plants, then that displacement of the goal and its subsequent artificial attainment is truly without meaning or earnestness; but if they possess a soul, then every different manner of displacing and thereafter reaching the goal will also indicate a differently felt need and a different play of satisfaction for the soul.

From this general point of view, the following examples will gain in significance for us; though it cannot, of course, be demanded that we should be able to specify in detail what that significance is for the psychical life of the plant.

In general, we observe that under some circumstances the plant behaves more passively in the fulfilment of its purpose, while under others it cooperates more actively; much as, in the satisfaction of human needs, fortune and skill participate in varying proportions. Fortune implies chance; but by chance it rains for the flourishing of every harvest.

Wind and gravity are taken into account in such a manner that they must needs deliver the pollen to the stigma. The outcome may in part go amiss; yet even if not all the pollen reaches the stigma, there is such an abundance of it that this is not necessary — indeed, the contrary might itself be contrary to the purpose.

In Hibiscus Trionum, Kölreuter counted 4,863 pollen grains in a single flower, of which in the finest season 50 to 60 sufficed for fertilisation. In Mirabilis Jalapa, the pollen from all five anthers amounted to 293 grains, and in M. longi-

flora to 321; yet in both cases, 2 to 3 pollen grains were sufficient for complete fertilisation.

The effect of gravity is found to be employed in the following manner. In erect flowers, the pistil is ordinarily so short in relation to the stamens, and in pendant flowers so long, that in either case the anthers must shed their pollen from above down onto the stigma — which is, where necessary, somewhat reflexed. This arrangement is not universal; yet nature is disposed to favour this proportion. The species of Aloe, which belong among those plants in which the pistil overtops the stamens, furnish a particularly fine illustration of the use of this device. In them, the flower stands erect before blooming and again after it has faded, but droops precisely during the time of fertilisation. Something similar is found also in the Asperifoliae, such as Cerinthe, Borago, Symphytum, Onosma, and Pulmonaria, and in many Liliaceae, for example Galanthus, Erythronium, Lilium, Hemerocallis, Fritillaria, Convallaria, and others.

The same significance attaches to the arrangement, common in monoecious plants, by which the male flowers stand at the upper end of the spike — as in the genus Arum, for instance — or the male catkins are situated above the female ones, as in the sedge (Carex), the bulrush (Typha), and others.

That the wind takes part in the work of fertilisation will not be doubted when one recalls how it frequently carries pollen away in prodigious quantities, which then settles, upon a sudden shower of rain, in what is called a sulphur-rain. In many plants, the transference by wind or insects is

further facilitated by the flowers being assembled in close proximity within a flower-head, a spike, or an umbel. In this way, not too much pollen is lost along the way.

Flowering grain fields may be seen at sunrise, when a gentle wind is blowing, wrapped in a thin mist — that is to say, the pollen of the newly opened blossoms, which, driven from its receptacles by the beating together of the ears, produces this phenomenon. Attentive farmers have also observed that grain does not set fruit more abundantly, nor form fuller kernels, than when a lively wind blows during the period of flowering. Pines, yew trees, juniper and hazel shrubs, poplars, and willows, when laden with dusting catkins and shaken or stirred by the wind, fill the air with a cloud of dust that the slightest breeze carries away. The assistance of the wind becomes especially important in the case of monoecious and, still more, dioecious plants, in the former of which the male parts are separated from the female upon the same plant, and in the latter upon entirely different plants. In an experiment conducted by Treviranus with Mercurialis perennis, no fruit was produced when the female individuals were 220 paces distant from the male and were moreover separated from them by buildings and shrubbery; whereas fruit did form when the distance was only 30 feet. (Jussieu observed something similar in two pistachio trees.) In the experiments of Spallanzani, all the ovaries of Mercurialis annua were fertilised when the female plant was placed close beside the male, fewer when it was somewhat removed, and none at all at a considerable distance. (Treviranus, Phys. II. 391. 393.)

Since wind had proved itself a helpful element in fertilisation, the question naturally arose whether water had not also been employed by nature for the same purpose. And indeed, although the use of water entails particular difficulties, of which we shall speak later, nature has nevertheless known how to overcome them in certain cases; and so we see in Ambrosinia the rain serving fertilisation by filling the spathe and thereby raising the pollen, which is produced below the stigma, to the requisite height; while in Vallisneria the water in which the plant grows conveys the male organs to the female. It is evident that the action of water has been called upon from above and from below, in vertical as well as horizontal directions. The process in the case of Vallisneria presents other interesting features as well, which it is well worth the trouble to become acquainted with.

"The spathe of Ambrosinia is boat-shaped and floats thus upon the water. The spadix, whose wing-like appendages are fused with the spathe except for a small aperture, divides the spathe into an upper and a lower chamber; in the lower are found exclusively the anthers, in the upper a single ovary. The pollen can reach the stigma by no other means than by rain filling the lower and half of the upper chamber, whereby the floating pollen is raised to the level of the stigma and can there produce tubes." (Schleiden, Grundz. II. 450.)

Vallisneria is an aquatic plant with separated sexes (dioecious), growing in the bays and canals of southern Europe, which lives at the bottom of the water and is anchored to the bed by means of numerous roots. In the female individuals, the flower bud sits upon a long stalk that is spirally coiled in

its youth, but which subsequently straightens, so that the flower may unfold at the surface of the water, and fertilisation may thus take place above the water. After fertilisation has occurred, the stalk shortens again, resuming its spiral windings; the young fruit is thereby brought back to the bed of the water, where it brings the seeds to maturity.

The behaviour of the male plant in the fertilisation of Vallisneria was formerly described with something of a fabulous embellishment, and such accounts are to be found repeated even in more recent writings. "The flowers of the male plant," it is said, "are held back on short stalks at the bottom of the water so long as they are growing; but at the time of ripening they detach themselves from their stalks, float up to the surface of the water, drift about opening upon it, and pollinate the female flowers that they encounter there." (Autenrieth, Ans. p. 254.) It is even asserted that this detachment of the male flowers from their stalks occurs through a vigorous movement. (Goethe, Ges. Werke, Vol. 55, p. 129.) According to the more recent investigations of Paolo Barbieri, Keeper of the Botanical Garden at Mantua, the true process is as follows: the male individual has a straight ascending shaft which, as soon as it reaches the surface of the water, forms at its tip a four-leaved (perhaps three-leaved) spathe, within which the male reproductive organs (stamens) are attached to a cone-shaped spadix. As the spadix and the reproductive organs grow, the spathe becomes insufficient to enclose them; it therefore divides into four parts, and the reproductive organs, detaching themselves from the spadix by the thousands, spread in a floating mass upon the water, appearing like sil-

ver-white flakes "which seem to press and strive toward the female individual." The latter, meanwhile, rises from the bottom of the water as the resilience of its spiral stem relaxes, and then opens at the surface a tripartite crown in which three stigmas may be observed. The flakes floating upon the water scatter their staminal dust against those stigmas and fertilise them; once this is accomplished, the spiral stem of the female withdraws beneath the water, where the seeds, enclosed in a cylindrical capsule, arrive at their final maturity. (Goethe, Ges. Werke, Vol. 55, p. 127.) The apparent "pressing and striving" of the male parts toward the female flower may well, however, have existed only in the imagination of the observer. I do not believe that one need add anything by way of poetic invention to the natural vital expressions of the plant in order to recognise in it expressions of a soul.

In Serpicula verticillata L. as well, a small plant with separated sexes found in the waters of the East Indies, the male flowers, when they are close to opening, detach themselves from the opened spathes and float toward the female flowers, resting upon the tips of the reflexed sepals and petals. (Roxb. Corom. II. 34. t. 164.)

A spontaneous participation of the plant in the business of fertilisation occurs partly by means of a particular manner in which the growth process takes place, and partly by means of voluntary movements of the reproductive organs.

In certain erect flowers, where the stigma stands upon a long style so far above the (often sessile) anthers that fertilisation seems impossible, the anthers open while the flower is still a bud, but close to bursting. At that moment the opened

anthers lie immediately against the fully developed stigma. The style elongates only after the flower has opened. This is the case in Proteaceae, Campanulaceae, many Papilionaceae, the hermaphroditic florets of Syngenesists, in Nymphaea, Hypericum, Argemone, Papaver, Paeonia, Oenothera, Impatiens, Ocymum, Canna, and so forth. (Treviranus, Phys. II. 378.)

In other plants, the reproductive organs, which are at first separated from one another, gradually approach one another through the growth of the floral parts, until fertilisation becomes possible.

With regard to the voluntary movement of the reproductive organs, it is most commonly the stamens that gradually move toward the pistil at the time of fertilisation, shed their pollen upon the stigma of the pistil, and then return to their former position. In other cases the pistil travels toward the stamens; in still others, both mutually seek each other out. (Cf. on this subject Treviranus, Biol. III. 349. V. 204. Treviranus, Physiol. d. Gewächse II. 379.)

To the first class, in which the stamens move toward the pistil, belong: Cactus opuntia, Fritillaria persica, Hyoscyamus aureus, Polygonum orientale, Tamarix gallica, Ruta graveolens and chalepensis, Zygophyllum Fabago, Sedum telephium and reflexum, Tropaeolum, Lilium superbum, Amaryllis formosissima, Pancratium maritimum, Parnassia palustris, Geum urbanum, Agrimonia eupatoria, various species of Ranunculus and Scrophularia, Rhus coriaria, Saxifraga tridactylites, Sax. muscoides, Sax. Aizoon, Sax. granulata, Sax. Cotyledon, and others. To the second class, in which the pistil moves toward

the stamens, belong: Nigella sativa, Sida americana, Passiflora, Candollea, Hypericum, Oenothera, Hibiscus, Turnera ulmifolia, and others. To the third, in which a mutual seeking takes place: Boerhavia diandra, all species of Malva, Lavatera, Althaea, and Alcea (Treviranus).

The stamens of certain plants observe, in their movement toward the pistil, a regular sequence: in Lilium superbum, Amaryllis formosissima, and Pancratium maritimum, the anthers approach the stigma one after another. In Fritillaria persica they bend alternately toward the style. In Rhus coriaria, two or three stamens rise simultaneously, describe a quarter-circle, and bring their anthers into close proximity with the stigma. In Saxifraga tridactylites, muscoides, Aizoon, granulata, and Cotyledon, two stamens incline toward one another from opposite sides over the stigma, and, having shed their pollen, spread apart again to make room for others. In Parnassia palustris, the male parts move toward the female in the same order in which the pollen ripens, approaching the stigma rapidly and all at once, yet withdrawing from it after fertilisation in three distinct stages. In Tropaeolum, of the stamens that are at first bent downward, one after another erects itself upon full opening of the flower, and, once the anther has allowed its pollen to fall upon the stigma, bends down again to make way for the next.

In the end, nature is wiser than we are. "Whatever difficulties may attend fertilisation," says Treviranus, "nature, when unrestricted in the application of her means — which cannot be said, for example, of cultivated plants — knows how to overcome them, either by bringing one of those means into

play, or by combining several. And so we often observe the pollen, betraying itself by its form and colour, upon the stigma, without being able to identify the means by which nature has conveyed it thither."

"Link observed in Valeriana dioica all the stigmas covered with pollen that could only have been carried thither by wind or by insects. In Lilium Martagon, the stamens and style attain their full development and maturity only after the flower has opened. The laterally inclined stigma is then remote from the anthers, and yet," says Treviranus, "in twelve flowers which developed one after another before my eyes, I saw it richly covered with the reddish pollen, without being able to account for nature's procedure in the matter, since I never observed insects at work, and the plant was sheltered from the wind by its position. Similar observations are to be found in Kölreuter and Sprengel."

Beyond the primary purpose of mediating the contact of pollen with the stigma, there are also subsidiary considerations that may come into account during fertilisation, and these are satisfied in often remarkable ways by particular arrangements in the structure and vital processes of plants.

Pollen, or flower-dust, consists essentially of small vesicles filled with fluid, which, upon reaching the stigma of the pistil, grow out into a long, thread-like tube that extends through the length of the pistil down into its cavity — the ovarian cavity — and there, by means of its fluid contents, fertilises the seed-bud that is attached internally within that cavity. This process cannot take place if the pollen vesicles have already burst and been emptied of their fluid contents

beforehand. The danger of this is brought about by contact with moisture, since pollen grains are inclined to absorb it, to swell, and to burst; and both dew and rain, as well as in particular the natural position of many aquatic plants, carry with them such a danger. Against this, the pollen of certain plants may perhaps be protected by a water-repelling, waxen coating; for we have, in certain cases, seen water itself play a helpful role in the process of fertilisation; yet this is at most but one of the means of averting the danger. In other cases the danger cannot reach the pollen at all, because the flower comports itself in a fitting manner against water or moisture, or arranges its growth accordingly.

Thus many plants close their corolla when rain threatens; many do so also at night, to escape the nocturnal dew, while others, at the approach of darkness, bend their flower-stalks so that the mouth of the corolla is turned downward. The common touch-me-not (Impatiens noli me tangere) even conceals its flowers beneath its leaves at night. In many flowers fertilisation takes place under the protection of special coverings, as in the vine and the rampion species, the papilionaceous flowers, the labiates, the Calyptranthes species, and others; in certain plant genera fertilisation already occurs within the bud before it has opened, as for instance in the bellflowers and the papilionaceous flowers, or it takes place at the very moment of opening, and this occurs only in dry weather. Not infrequently, too, the shifting position of the flowers caused by the wind — which commonly accompanies rain — prevents the latter from penetrating; of this C. C. Sprengel has given a vivid illustration in the work noted on

page 165. Should considerable moisture nevertheless reach the inner parts of the blossom, fertilisation generally fails; and it is for this reason that rainy weather during the flowering of fruit trees and grain is so unwelcome to the husbandman.

Particularly interesting, however, are the means employed in certain aquatic plants to accomplish fertilisation with the exclusion of water.

The water caltrop, Trapa natans L., germinates at the bottom of the water and develops there in its early growth; but as soon as the time of flowering approaches, the leaf-stalk swells into a cellular, air-filled bladder. These bladder-like leaf-stalks stand close together in a kind of rosette of leaves, and raise the plant to the surface of the water; flowering takes place in the open air, and as soon as the season of blooming has passed, the bladders fill once more — through the absorption of the air — with water, and the plant sinks back to the bottom, where it brings its seeds to maturity. (Decand. II. 87.)

The species of Utricularia present a still more complex arrangement. The roots, or rather the submerged leaves, of these plants are extraordinarily much-branched and beset with a multitude of small, rounded pouches — utriculi — furnished with a kind of moveable lid. In the young Utriculariae, these pouches are filled with a slime heavier than water, and the plant, held back by this ballast, remains at the bottom. When the season of flowering approaches, the plant secretes air, which penetrates into the pouches and drives out the slime as the lid is raised; when the plant is in this manner

equipped with a multitude of bladders filled with air, it slowly ascends and finally floats at the surface of the water, so that flowering may be accomplished in the open air. When the season of flowering has passed, the root begins once more to secrete slime, which takes the place of the air within the pouches: the plant thereby becomes heavier, sinks to the bottom, and brings its seeds to maturity at the very spot where they are to be shed. (Decand. II. 87.)

In other aquatic plants the same end is achieved more simply by their not flowering until their stems have reached the surface of the water; such is the case, for example, with most species of Potamogeton, the mints (Menthae), the water sedges (Carices aquaticae), the bur-reeds (Sparganium), and others.

Even beneath the water, fertilisation is in certain plants able to proceed shielded from it.

Eelgrass (Zostera marina), for example, is anchored by its roots to the floor of the sea and cannot extend itself sufficiently to reach the surface of the water; in compensation, however, it flowers within a leaf-fold (duplicature de feuille) which, though open at the sides, retains a certain quantity of air secreted by the plant itself, so that the male flowers enclosed in this cavity together with the female flowers are immediately surrounded by air alone, and not by water.

In the water crowfoot (Ranunculus aquaticus), which, though it ordinarily flowers in the open air, may readily be exposed to the danger of submersion when the water is high, provision has been made for this eventuality as well. Ramond and Batard found, in lakes suddenly rising, the flowers of this

plant submerged by the swelling of the water without detriment to fertilisation. This is connected with the fact that the pollen emerges early to the anthers while the flower is still a closed and spherical, air-containing

The pollination of plants offers no less teleological interest than their dissemination, for Nature's concern to secure a continuous succession of plant-souls is equally manifest in the latter; though the provisions made in this regard cannot, for the most part, be brought into as direct a relation with the sensations of the plant itself as those which pertain to the process of fertilisation. August de Saint-Hilaire and Choulant observed similar phenomena in the floating water-plantain (Alisma natans) and in the knawel (Illecebrum verticillatum). (Decand. II. 84.)

"No more calculated," writes Autenrieth (Ansichten von Natur- und Seelenleben, p. 257), "can the care of many mammals and birds appear, in driving away their young as soon as they no longer require assistance, so that, were all to remain gathered in one place, the scanty nourishment — that privation from which civilised mankind so often suffers through its own fault — might not at last fail them all, than the bursting capsule of the European yellow balsam, Impatiens noli-me-tangere L., appears to be contrived, by means of which the seeds are flung far and wide; or than the mechanical form of the little hooks with which certain seeds are furnished, that they may attach themselves to passing animals and be carried by them into the distance; or the manifold structure of the feathery crowns of many seeds, by which they may be borne

away and scattered by the wind — all of these evidently serving that same end."

This observation gains in interest when we observe how, in circumstances where the possible thriving of the seed is confined to a very specific situation, there may also occur contrivances that rather impede the dispersal of the seed, and work instead toward its being fixed in the immediate vicinity of the parent stem. The mangrove tree furnishes a fitting example of this.

The mangrove, Rhizophora L., grows at the mouths of rivers in the torrid zone and along flat sea-shores, but only in the mud, and only so far as that mud is alternately covered by the tide with salt water. The seeds could thrive neither further out to sea nor further inland; and so they are already, by the very manner of their growth, arranged to take firm root at once precisely where they fall from the parent tree, and may therefore expect to find soil as favourable as that which sustains the parent. On the receptacle of this tree's flower there gradually forms a fleshy, hollow outgrowth — a kind of platform, as it were, extending the seed out into the open air — upon which the seed, by means of a stalk, advances progressively further. The almost cylindrical stalk, ultimately some one and a half inches in length, draws the seed ever further from this base. The seed itself is oblong and ultimately some ten inches long, becoming thicker and heavier toward its free end, which terminates in an awl-shaped point. When ripe, it hangs perpendicularly from the tree; at the same time, however, its connection with the stalk grows ever looser, until at last it detaches itself entirely. By its own weight, and aided by

its awl-shaped point, it then penetrates of itself nearly an inch into the marshy ground and remains standing upright within it. Yet it had required almost a full year to ripen upon the tree, had germinated within its husk, and had already developed a substantial root. It is therefore able to take hold almost immediately. Jacquin observed such seeds falling through as much as three to four feet of water to the bottom and remaining there in an upright position; and he found, at such depths, seeds that had taken root and sprouted again into young trees. (Dict. des sc. nat. T. XIV. art. Rhizophora, 387.)

According to an observation by Schübler, the seeds of aquatic plants are generally heavier than water, and thus, upon falling from their cases, sink at once to the bottom where they are able to germinate; whereas the seeds of most tall trees are lighter, and therefore, when they fall upon the surface of water, float and are carried by wind and current to the neighbouring shore. (Kästners Arch. X. 426.)

Grain grows more securely when covered by earth than when merely scattered upon the surface. With a view to this end, Nature has furnished the seeds of the wild or fly-oat (Avena fatua L.) with the following contrivance. The awns of this plant are bent in their middle, as it were at an angle, partly twisted like a cord, partly straight. When the seed has become fully ripe and dry, the lower portion of the awn is highly hygroscopic. Upon becoming moist, it untwists, and by this alternating movement the grain is raised now upon the tip of its lower end and now upon that of the awn, only to sink again as the awn, in untwisting, straightens itself once

more. In this manner the grain is compelled to advance one step after another, because the direction of the fine hairs on the grain and the delicate spines on the awn permits forward motion only in one direction — toward the end not furnished with the awn — and not backward. By the alternation of rain and the return of dry weather, the fly-oat thus creeps across the fields until it reaches a stubble or a clod of earth beyond which it cannot pass, but by which obstacle it is now also covered for germination. (Pflanzensystem von Linné XII. 43.)

Let it not be forgotten that all which has here been communicated consists only of isolated examples drawn from particular domains of plant life, in which the operation of the principle of purpose appears especially striking to our mode of apprehension. Were we willing and able to pursue the life of plants in all its aspects and in every detail, we should unquestionably discover the same purposive governance everywhere, and find the harmonious concurrence of all teleological considerations far more wonderful than any single detail can appear to us in isolation.

XII. The Relation of the Plant to the Animal

XII. Stellung der Pflanze zum Tiere.

One objects: the soul cannot extend downward from the animal kingdom into the vegetable kingdom, because one already observes it gradually extinguishing as one descends from the animal toward the plant realm, and becoming altogether ambiguous in proximity to the latter. The plant kingdom stands, on the whole, lower than the animal kingdom; but if even the lowest animals retain nothing appreciable of soul, then nothing remains for the still lower-standing plants — nothing whatsoever.

Polyps, for instance, are already of a half-plant-like nature. They sit, at least for the most part, firmly attached to the ground by a stalk, put forth branches, shoots, and some apparently produce blossoms, and so forth. Yet how dark and imperfect are already the signs of ensoulment even in them! If one can attribute to these most mobile and soft of animals nothing more than a dim and murky remnant of soul, how should anything of the sort appertain at all to the wholly rigid and stiff plants, which are, so to speak, merely lignified polyps? Among the lower creatures there are quite a number regarding which dispute continues to this day as to whether they are to be counted among animals or plants; and this dispute coincides with the question of whether signs of a soul are to be found in them or not — so ambiguous do these

signs become here. If there is already doubt whether soul exists where the decision between animal and plant still wavers, then there can be no further doubt that no soul exists where the full decision has fallen in favour of the plant.

And yet, it is merely a matter of grasping this argument with precision, and it turns itself entirely to the opposite side.

What gives us, in the first place, the right to find in polyps, infusoria, and other so-called imperfect — though in truth merely simpler — animals nothing more than doubtful traces of soul? Instead of signs of a dark and murky remnant of soul, I find in them only the signs of a simple and sensory play of the same. The great receptivity of these lower animals to various stimuli, the clear capacity for discrimination which they possess in this regard, the vivacity and decisiveness of their movements, the definite direction which they impart to those movements toward definite ends, the character of spontaneity perceptible therein, the resolute resistance with which they meet every interference with their natural conditions of life, the conflicts into which they enter with one another — all of this speaks entirely against a wavering, dull, half-submerged soul-life still barely distinguished from unconscious natural existence.

Let us but look more closely at the vital manifestations of the polyp, and it may well appear that the apparent obscurity of its soul is in truth merely a consequence of the genuine obscurity of our observation.

When an extended arm-polyp (Hydra) is touched, or the water in which it dwells is agitated, it suddenly contracts itself into a small lump — surely a sign of lively sensibility. It

follows the light, and if one places a vessel containing several polyps, one finds after some time that all have gathered on the illuminated side. The polyp thus possesses various kinds of sensory perception. It is enormously voracious, seizes eagerly with its tentacles after prey, and two polyps will frequently contend with one another for the same morsel. These, then, are signs of lively appetites. It chooses and discriminates with great definiteness among its food, consuming only animal nourishment while rejecting vegetable matter; and among animal food it makes further distinctions, notably never seizing upon polyps of its own kind, even when left to starve and these are allowed to fall upon its outstretched arms, while it seizes at the first touch those small creatures upon which it willingly feeds. Here a clear capacity for discrimination reveals itself (Trembley).

What, after all, does one find in the polyp other than a being of thoroughly developed sensibility, even if perhaps nothing beyond this? The entire play of its soul revolves around the satisfaction of that sensibility by the shortest possible path. But sensory perceptions and appetites may be of the most vehement and decided kind, and the simplicity of the play in which they are engaged favours rather than diminishes their intensity and decisiveness. One need only look at the simplest and most primitive of men. Have they less vehement and decided desires than the most cultivated and refined? Such a soul-life may well be called dark, insofar as the higher light of reason is absent. But the light of sensibility may burn in its own way as brightly as the higher light of reason, as fat burns as brightly as ether; and a low-placed light illuminates

the small space within its reach all the more vividly for its nearness.

What holds for polyps holds also for infusoria, insofar as we can, given their minuteness, follow their manner of life. They exhibit in part the most lively movements bearing all the characters of animal spontaneity; and if not all are equally animated, there are, after all, sloths among the higher classes of animals as well, and one cannot, as was discussed earlier, seek the sole measure of the vivacity of inner sensations in the vivacity of outward movement.

Incontestably — and easily traceable up to certain limits — the simpler and more sensory soul-life of these lower beings is bound up with their simpler bodily organisation. Nature has traversed a great scale in this regard from man down to the lowest animals; but it is precisely not a scale of strength and clarity, but of the complexity, elevation, and significance of soul-life that is traversed therewith. The two should not be confused, as they are however in the argument set forth above.

In a certain sense — properly understood — organisms may be conceived as machines which, unlike our artificial machines, generate within themselves the force for their own operation, and accompany its generation and employment with consciousness, suffusing it with feeling; being destined not for the mediate service of a soul external to them, but for the immediate service of one within. In other respects they exhibit relations of greater or lesser complexity analogous to our own machines, and, according to the case, they serve ends correspondingly more complex or more simple. Now the

simplest coffee-mill still grinds its coffee as well as the high-speed press performs its intricate business of printing. And I think, if each of our machines were to accomplish what is incumbent upon it by its own force and with its own consciousness, the coffee-mill too would master its business no less thoroughly, would suffuse it with feeling no less fully than the high-speed press. Not the decisiveness or intensity, but only what one calls the elevation of consciousness, would be less; insofar as the simpler end also demands a lesser range of oversight. As we can here most readily conceive it to be, so without question it actually is in organisms. With the increasing complexity of organisation there will be bound also an increasing elevation — but not strength or decisiveness — of consciousness. In the more complex organisation, relations to relations are added, and higher relations are superimposed upon lower ones,

which are absent in the simpler organisation, and because they are absent, the consciousness corresponding to them is absent as well. But the consciousness of the simplest and lowest relations may be as wakeful, vigorous, living, and decided as that of the highest — indeed easily more decided and more living; for every added complexity consumes force, and where it diminishes for the organic, it will diminish simultaneously for the psychic.

Granted, then, that plants were in truth organised still more simply than polyps and infusoria, this would yet contain no binding reason for holding their soul to be less wakeful and living than that of these very animals, which shows itself

wakeful and living enough. It would prove only for a still simpler and lower manner of their soul-life.

But it cannot even be conceded that the most fully developed plants are more simply organised than the simplest animals, and hence that the plant kingdom stands in this respect wholly and entirely beneath the animal kingdom — even if, regarded broadly and on the whole, this relation between the two kingdoms remains correct, insofar as nowhere in the plant kingdom has organisation advanced to such a degree of complexity as in the higher classes of the animal kingdom. In any case, however, the plant kingdom, like the animal kingdom, rises again from that ambiguous intermediate realm where one cannot rightly determine whether animal or plant, up toward greater complexity; and this can ground no other conclusion than that the development of soul-activity, which increases with organic complexity, instead of sinking still further through the plant kingdom beyond the intermediate realm, rather ascends again through it, if indeed in a different direction.

The following reflection lends support to this view: According to the unquestionable findings of geology concerning the fossil world, worms and molluscs existed upon the earth before amphibians, amphibians before birds and mammals, and these before man; in short, viewed on the whole and in broad terms, the creation of each lower class of animals preceded that of every higher one, and indeed by many thousands of years. Within the plant kingdom, a similar progression of creation from lower to higher organisations shows itself, on the whole and in broad outline. Were the plant king-

dom to stand absolutely below the animal kingdom, one would necessarily have to presuppose that the plant kingdom, viewed in the aggregate, came into being before the animal kingdom. Nothing, however, is more certain than that this is not the case; rather, all the findings of geology concur in showing that the plant kingdom was by no means prior to the animal kingdom; one might sooner doubt whether it did not perhaps arise later. The most probable conclusion, however, remains that they arose simultaneously. The lowest plants, together with the lowest animals, formed the common point of departure for organic creation, and from thence it elevated itself in both kingdoms alike. It may indeed have attained, within the animal kingdom, a greater height overall, if we measure height consistently by internal complexity; yet the greatest height to which it advanced in the plant kingdom is still far higher than the lowest rung of the animal kingdom. And if the plant kingdom has remained behind in height of development taken as a whole, it has in turn gained the advantage in richness of outward development.

To set plants, as rigid and stiff bodies, in opposition to the soft, mobile polyps does indeed sound greatly to their disadvantage; yet one may, and with greater justice, arrange the comparison otherwise. The polyps, and especially the hydra, are soft, almost uniformly appearing masses, in which only careful dissection can laboriously discern any separation of organic elements, whereas the higher plants are articulated, with the greatest delicacy and clarity, into cells and tubes of the most varied form and function, permeated by streaming saps, and put forth leaves and roots in search of nourishment

just as actively as the polyp extends its arms toward the same end, only far more broadly and widely. Must it not strike everyone from the outset as an absurdity that the baobab tree, with its age of several thousand years, its enormous growth of trunk and branches, and its equally rich outward abundance as well as its careful inner elaboration of parts, should stand lower upon the ladder of creation than the pitiably small, crudely fashioned polyp, or the even more diminutive and simply organised infusoria, which after a brief span dissolve again into the slime from which they seemed only just to have been assembled? The smallest infusorian may still possess an intestine, and the greatest tree may have none; but does not every tube in the tree that carries sap from below upward already possess, in a certain sense, the significance of such an intestine? The baobab is an immense organ, while the infusorian is the tiniest of pipes. And should nature have expended so incomparably more of mass, force, and organisation upon a soulless being than upon one possessed of a soul? How is one to reconcile this with a rational teleology? Or will one say here again: the baobab is of use to the monkeys? That would be as much as to say that Saint Peter's Basilica is of use to the pigeons that perch upon it. Concerning this matter, I think enough has already been said in earlier sections.

In essence, it has long since been abandoned to arrange organic creatures according to the pure schema of a staircase; it does not work within the animal kingdom considered by itself, nor within the plant kingdom considered by itself; but it works equally little in establishing the relation between the

plant and animal kingdoms. The concept of the height of an organic being in relation to another is, on the whole, a fairly indeterminate and ambiguous one; and while it may well be found that, by most of the relations according to which one might measure the elevation of one creature above another, animals stand on average above plants, this will hold neither with respect to all relations, nor between all animals and all plants indiscriminately. The whole argument that plants have even less claim to a soul than the most lowly animals, because they stand even lower than these, thereby loses its entire foundation from the outset. They will certainly stand lower in certain respects, but in other respects unquestionably far higher: indeed one may well maintain that every organic being stands, in some particular respect, higher than every other. The guiding principle of its formation was precisely to allow a certain kind of purpose to be achieved most perfectly and directly by means of this particular arrangement; accordingly, the drives and sensations of that being must also be most perfectly and directly attuned to the relation toward this purpose, to the need of its fulfilment, to the pain of its failure, and the pleasure of its attainment, for otherwise the whole purposive play would be blind and deaf. From this standpoint, which is precisely the most important for our subject, no general hierarchy of beings can in fact be established at all, or rather every being may be placed at the head of a particular hierarchy in which its own specific purpose is taken as the primary point of view. One may of course distinguish between the height or worth of purposes themselves; yet this too admits of various standpoints. Finally, in order to

have something comprehensive, one may attempt to establish a hierarchy according to the subordination of the general over the particular among purposes, and this will approximately coincide with the standpoint employed above and underlying the conventional arrangement, namely that of greater or lesser complexity of organisation. There may be creatures capable, through the linked consideration of many purposes, of simultaneously satisfying a more general, superordinate purpose, while the independent and immediate fulfilment of each individual purpose must necessarily suffer a restriction through the concurrent consideration of the rest. Such creatures may on the whole be called more perfect, yet for that very reason all the more imperfect in regard to each individual purpose than those beings which have only singular or predominant purposes to fulfil. The best example is afforded at once by man, in whom the linked fulfilment of as many purposes as possible simultaneously is clearly intended, and is also on the whole best achieved. On the other hand, he has not such swift legs, not such keen eyes, not such tenacious claws as many animals; yet the combination of all these is so favourable that, with his weaker individual attributes, he nevertheless accomplishes more on the whole and indirectly than the animals to whom he is inferior in the particular and the immediate. This is admittedly due in large measure to his understanding; yet the psychic organisation is everywhere connected with the physical. That yields no other principle.

Meanwhile, not all beings can be arranged in a single sequence of superior and inferior even on this basis, since many spheres of purpose are coordinated, others interpenetrate one

another, and thoroughness in the fulfilment of a purpose in all its aspects may easily acquire a more general significance than what one might call the merely sketchy fulfilment of several purposes at once. Thus, after all, the simple concept of a gradation of height remains inadequate to represent the complex relationship in which organisms stand to one another. And however one may attempt to employ this concept in ordering them, plants will not accommodate themselves neatly beneath the animals; and even were that the case, only a lower order of sensory soul, but not no soul at all, could on those grounds be denied them.

Naturally, if the distinction in ensoulment between animal and plant falls away, the long-contested dispute over the many creatures of the intermediate realm, concerning which of them are properly to be counted as animal and which as plant, must take a new turn, or lose a turn it has frequently taken before. Hitherto the soul itself, understood as spontaneous will and sensation, was often reckoned as the distinguishing criterion between animal and plant, without, however, being able to determine the presence or absence of the soul by any means other than external signs, the very validity of which depended in turn upon the assumption that only animals are ensouled. But if plants are as fully ensouled as animals, then any such distinction falls away altogether.

There will henceforth be considerably less interest in maintaining a strict dividing wall between the animal and plant kingdoms, and in insisting that doubtful creatures be placed definitively on one side or the other of that boundary, than has hitherto been the case. The subjective passion that

the dispute — whether animal or plant — has so often aroused was undeniably itself dependent upon the assumption that what was simultaneously at stake was the existence or non-existence of an objective source of feeling. Once this assumption is removed, there remains only the more superficial interest of arriving at firm criteria for distinguishing animal from plant according to their bodily constitutions; in this regard one ought from the outset to abandon exaggerated demands, when one recalls the uncertainty of all principles of classification even within each of the two organic domains separately, and no longer sees any reason why that uncertainty should not also extend from one domain into the other. In fact all ground for such a restriction falls away as soon as one grants souls to plants as well as to animals. For so long as this was not the case, one could indeed believe that the difference between ensoulment and its absence must express itself in a correspondingly decisive difference in the bodily domain, one that would permit no bridge between the two.

It is my view that, up to certain limits, it will always remain arbitrary what and how much of the creatures belonging to the intermediate realm one chooses to place on one side or the other. The least arbitrariness will prevail when the naturalist proceeds from the concepts of animal and plant as they have taken shape in living linguistic usage, and seeks only to fix the indeterminacy of that usage; for otherwise everything would be arbitrary from the start — yet in doing so precisely this it becomes apparent that he cannot ultimately escape arbitrariness after all. For in common life those concepts have formed themselves around a complex of characteristics that

usually occur together, without any strict delimitation of that complex or any decision as to a principal characteristic, with the higher animals and plants chiefly in view. But when, as is in fact the case, the characteristics of these complexes in the intermediate realm, and already in the approach thereto, begin partly to diverge, partly to mingle and encroach upon one another, the decision as to which characteristic, or which narrower complex of characteristics, shall ultimately determine the choice of name and the placement on one side or the other of the required boundary between animal and plant no longer lies in the nature of the thing or in the usage of language, but purely in the subjective judgment of the naturalist, or in the direction he has chosen to give his principle of classification — a direction that cannot be binding upon others. And whatever he may choose as his principal distinguishing characteristic, or whichever complex of characteristics he may select, however striking the distinction may appear when the higher forms of plant and animal are set against one another, there will nevertheless always arise, in the borderland, ambiguous and doubtful cases where even the individual characteristic begins to waver in some degree.

Two principal distinguishing characteristics seem chiefly to recommend themselves, and have also been most frequently employed, of which the one relates to structure, the other to the expressions of life. According to the former, a creature is declared animal or plant depending on whether it absorbs its nourishment into the substance of its body more through internal or invaginated surfaces — the intestinal canal, the stomach, to which a mouth belongs — or through external

evaginated surfaces such as leaves, root fibres, and the like; according to the latter, depending on whether its outward life expresses itself more through apparently free locomotion of the whole or of the parts, or through mere growth. The plant and animal kingdoms in their higher forms are indeed separated very distinctly by the combination of both these characteristics; yet neither characteristic, considered in itself and in the nature of the organism, possesses anything absolutely divisive, as is sufficiently demonstrated in the intermediate realm, because invagination and evagination, locomotion and growth, can partly combine in one and the same organism, and partly alternate in it over time in such a manner that one cannot always readily say which is to be regarded as the preponderant characteristic; moreover the structural characteristic does not stand in so essential a connection with the functional one that both always occur in conjunction.

The impossibility of arriving at a sharp distinction by confining oneself to these two characteristics has led to the introduction of others: whether in the movements "the external contours of the body are altered by voluntary contraction and expansion of the bodily parenchyma" (Siebold); whether cilia or feet appear as organs of movement; how multiplication is effected; whether this or that chemical circumstance is present. But what holds for the former characteristics holds no less for these. Not one of these characteristics has hitherto fully served the purpose of sharply distinguishing animal from plant. And this circumstance — that it proves impossible to divide the plant and animal kingdoms sharply by bodily characteristics — may itself serve, conversely, as an argument

that no dividing wall exists between them with respect to the psychical either.

The absence of a stomach and of any internal organisation resembling that of the animal, in the presence of apparently free locomotion of the whole or of the parts, is common enough — as among the oscillatoria, the algal spores, and generally the creatures cited in the note on p. 184, regarding which the dispute as to animal or plant subsists. Those who see in these only plants will, to be sure, maintain that their movements are not truly voluntary movements. But what is to be called voluntary in this context and distinguished from what is not has hitherto always been more a matter of an aperçu determined by the individual opinions of observers than of fixed criteria. Indeed not only the external characteristics, but the very philosophical concept of voluntary action is something so unstable that one can scarcely found upon it an exact natural-scientific distinction, as Ehrenberg has attempted to do with the following: "The movements of animals," he says, "have the purpose of voluntary change of place; the movements of algal seeds, and so forth, do not have the purpose of voluntary change of position, but only that of individual rotation and development toward the tensed form. These have, as appears evident, the more plant-like character conditioned by the external (stimulus); those the more animal character conditioned by the internal (will). The presence and absence of mouth and intestine powerfully distinguish both formations." (Transactions of the Berlin Academy of Sciences, from the year 1833, printed 1834, p. 157.) Elsewhere Ehrenberg adduces as a further characteristic of animal na-

ture multiplication by division — which, however, also belongs to creatures that are counted by others among the algae.

How entirely without principle the attempts to distinguish animal from plant still vacillate may be illustrated, among other examples, by the following: Meyen declared the closteria and similar forms to be plants on the grounds that he had found starch in them; whereupon it was objected that animals too might contain starch. Unger declared the motile algal spores to be of animal nature because they moved apparently freely, and indeed by means of ciliary organs; whereupon it was objected (by Siebold) that plants too might move in this manner and possess ciliary organs. Thus one says whatever one pleases in order to preserve one's particular system. Siebold (Comparative Anatomy, I, 8) lays great weight upon the voluntary contraction and expansion of the body as a characteristic of the animal, yet finds himself thereby compelled (ibid., p. 14) to declare the presence of mouth and stomach as inessential, and to speak of animals that absorb their nourishment through their entire body surface — that is, through external surfaces — as do the opalines. For him, therefore, neither mouth and stomach, nor apparently free locomotion (unless combined with contraction and expansion), any longer counts as a characteristic of the animal.

The difficulties mentioned above, grounded in the very nature of the subject, of drawing a firm distinction between plant and animal are further complicated, particularly in the case of small organisms, by difficulties partly of observation and partly of the interpretation of observations. Whether a

stomach or intestinal canal is present can often be determined only with great uncertainty, or indeed not at all: even Ehrenberg's celebrated method of feeding infusoria with pigments — first employed by Gleichen — is no longer universally accepted as a conclusive procedure for this purpose. (Siebold, Vergl. Anat. I. 15 ff.) Meyen frequently describes as an ordinary plant cell (in his algal genera Pediastrum, Scenedesmus, Staurastrum) what Ehrenberg (in his Polygastrica) terms a stomach; indeed, the concept of a plant cell with an opening and that of a stomach with a mouth might, in certain instances, genuinely run together. Siebold declares Ehrenberg's stomachs to be in part merely droplets beneath the integument. Whether local movements arise through the play of vital forces, or through external mechanical causes (such as Brownian molecular motion), or after the manner of the movements of camphor upon water, is likewise not always easy to discern from their appearance; and here too the differing presuppositions of the observers generally determine the interpretation. But granted that a cause of this last kind were to come into play, we should ultimately encounter the vexatious question of the distinction between the life-process and the inorganic process altogether. Just as well as the vocal cords vibrate as strings, a spore might move upon water by the ejection of a volatile oil (as Schleiden formerly supposed), and yet the motion would still have to be called vital and animal in character.

Sharpness and precision undeniably befit every science and constitute principally its exact character; yet it does not seem to me exact to seek such precision where it does not in

fact reside in nature itself, or to seek it in a manner inconsistent with how it resides there. For nature is certainly determinate everywhere, but not therefore according to those closed general concepts and types that would best suit our philosophy. All general concepts and types of nature interpenetrate one another, yet we are all too ready to sever the interlocking joint with the knife of the system. I should not have permitted myself, being no specialist in the field, to venture an opinion on this matter, were it not that so many specialists seemed to me to approach this very subject all too much in the manner of specialists. Once the departments have been apportioned for nature, nature is expected to avail herself of them accordingly.

It remains in any case a fact that the resemblances and encroachments between the plant and animal kingdoms accumulate the more abundantly the further one descends in both kingdoms, and thus the occurrence of an intermediate boundary at which the distinction truly becomes altogether fluid can in itself hold nothing surprising.

In a certain sense, this increasing resemblance of the two kingdoms as one descends through the animal and vegetable worlds may already be found to be conditioned by the concept of their increasing simplicity; yet as one approaches the undecided borderland, there enter from each side actual encroachments upon the characteristic peculiarities of the higher stages of the other. How much that is stem-like, branching, budding, tendril-bearing, leafy, flower-like, and spiral appears near the lower boundary of the animal kingdom; one might say that the animal kingdom here plays masquerade in the

disguise of the vegetable kingdom. Conversely, in the lower levels of the plant kingdom, plants in part lose their branching, leafy type; here rounded forms appear, as in the fungi, there articulated forms, as in the confervas (which are at least obscure approximations to the higher animal). One need only think further of the resemblances which lower animals acquire with plants by virtue of the fact that they can in like manner be divided and multiplied by division without detriment to life, and how conversely lower plants (many algae) bear freely motile offspring (of which more below). Cellulose has recently been discovered in the integuments of several rather lowly animals (in the mantle of the ascidians and the remaining salp-like tunicates); conversely, fungi are well known for their abundance of animal-like substances, and so forth.

With regard to the formal resemblance of lower animals to higher plants, one need only consider (perhaps in the engraved plates of Ehrenberg's great work on infusoria) the similarity of the vorticellae to branching plants bearing flowers, whence they derive their very name of flower-animalcules. Especially rich, however, is the class of coral-like animals in resemblances to plants. As a suitable means of bringing this into the light, I share here the following (verbatim) extract from a description of these animals given by a naturalist (Dana), in which expressions recalling vegetable forms are found on every side (here emphasized in print).

"The composite structure of coral animals is a consequence of their mode of budding, from which all their manifold forms proceed. Some of these, such as the madrepores,

gorgonians, astraeae, and so forth, are sufficiently well known and have generally been regarded as the most frequently occurring, if not indeed the only forms; yet a prodigious variety prevails among their shapes: some grow as leaves rolled one above another, resembling a head of cabbage; others consist of tender, crisped, irregularly arranged leaflets. The surface of each leaf is covered with polyp-blossoms, through whose growth and secretion it has been produced. Resemblances to an oak branch and an acanthus branch, to fungi, mosses, and lichens might likewise be discovered. The vascular madrepores rest upon a cylindrical base, which in the living state is entirely covered with polyp-blossoms; they consist of a network of boughs and branches that spreads gracefully from its centre and is covered over and over with coloured polyp-brood. The domes of the Astraea are perfectly symmetrical and frequently attain a diameter of ten to twelve feet; the Porites mounds rise above twenty feet in height; there are also columnar and club-shaped corals, as well as corals of the most varied forms."

"Every composite zoophyte springs from a single polyp and grows by continued budding into a tree or a dome. A trunk of Astraea measuring twelve feet in diameter unites some one hundred thousand polyps, each of which occupies a quarter of a square inch; in a Porites, whose animalcules are scarcely one line in breadth, their number would exceed five and a quarter millions. In this animal, therefore, an equal number of mouths and stomachs are united into a single plant-animal, and jointly contribute to the nourishment, budding, and enlargement of the whole; they are also laterally

connected with one another. There are, again, others that never produce buds and dwell in solitary chambers, now as small cups, now as flat dishes, and so forth."

"The polyps of a composite group differ according to the manner of their attachment to one another. Either they are connected only at the base, where each represents a single arm and the whole assumes a tree- or shrub-like aspect; or they are connected laterally up to the tip and thus form massive shapes. In the former case small calyces will be raised for each separate polyp; in the latter only flat cells, as in the gorgonians, where the polyps protrude but their calyces are absent." (Dana in Schleiden's and Froriep's Notizen, 1847, June, no. 48.)

It may perhaps be objected that the great resemblance of the coral animals to higher plants concerns only the entire polyp-stocks and not the individual polyp-animals (the animal-blossoms) themselves. This is true; but why should we compare the individual animal-blossoms with entire plants, when they exhibit rather only analogous relations to individual plant-blossoms? The question of how far the individual polyp-blossoms and individual plant-blossoms are to be regarded as independent individuals recurs in both kingdoms in the same manner, and the same grounds which must occasion us, notwithstanding all that can be distinguished as individual within the entire plant, to regard the whole plant itself once again as a superordinate, self-contained individual, accrue more or less to the benefit of the entire polyp-stock as well. It arises just as surely from a single egg as the plant from a single seed; its form develops according to a fixed idea,

yet with a certain freedom; each polyp is connected with the others by animal substance (especially if one takes into account Edwards's investigations into the animal organization extending through the calcareous skeleton).

Indeed, there appear to be no lack of direct signs of psychical co-operation among the members of polyp-colonies. Particularly interesting to me in this connection is the following observation by Ehrenberg (in his great work on infusoria, p. 69) concerning the well-known spherical organism, volvox globator, which, though not belonging to the coral animals, likewise forms a kind of polyp-colony from many individual animalcules that, seated at the surface of a sphere and connected only by thread-like tubes, are described thus: "If one introduces a little blue or red dye into the water beneath the microscope, one can perceive quite distinctly a vigorous current about the spheres. This is a consequence of the combined action of all the individual animalcules, which, like herds of animals, flights of birds, or even singing and dancing human beings and assemblages of people, assume a common rhythm or a common direction, often without command and without becoming clearly conscious of the will to do so. All the polyp-colonies swim, and the warm-hearted as well as the cooler-reasoning naturalist recognises therein a social instinct, consisting in strength and yielding for common purposes, a condition that demands a mental activity which one is not entitled, but merely tempted, to underrate. One must never forget, moreover, that all the individual animalcules possess sensory organs comparable to eyes, and that they therefore do not rotate blindly in the water, but as citizens of

a great world remote from our judgment share with us ourselves the enjoyment of a sensation-rich existence, however proudly we may comport ourselves."

The whole question concerning the relationship between superordinate and subordinate individualities, whether viewed from the physical or the psychical side, is in general still a very obscure one. One must also not forget that, for all the resemblance between plants and polyp-colonies, considerable differences remain between them, and that conclusions drawn by analogy from the one to the other cannot be made without great caution. It would be possible that the plant is in fact a being far more bound to unity than a coral growth. At the very least, I am not aware that one has observed in coral growths such decided signs of the co-operation of all parts as we shall come to know in the thirteenth section in the case of plants.

Applying the two characteristics set forth above, one would have to say of coral growths that the growth as a whole is a plant, while the individual polyps attached to it are animals. It is true that the surfaces by which nourishment is absorbed (the stomachs of the individual polyps) are here throughout invaginations, but they are invaginations occurring on the evaginations of the growth, just as, conversely, in the case of higher organisms that are to be regarded as animals in their entirety, it is evaginations (villi) that project from invaginations (the intestinal canal) through which nourishment is absorbed.

If one considers the extraordinarily great transformations that occur within the same creature, both in the animal and

the plant kingdom, over the course of various periods of life, and which in some very lowly animals, such as medusae, are even more striking than in insects, it can, in the light of all that has been said above, contain nothing incredible in the supposition that a creature might, in the course of such changes of life-period, alternately assume the animal and the plant character. That in lower creatures alterations in this direction do actually occur is, in view of the examples shortly to be cited, beyond doubt; the only point still in dispute is whether this goes far enough actually to transform a proper animal into a proper plant, or conversely, a question which, in view of the preceding reflections, can scarcely admit of any decision other than one determined by arbitrary choice.

Schleiden (Grundz. I. 265) says, admittedly, in his customary blunt yet scientifically zealous manner: "Only a science ailing with fantastic mysticism, and not a clear and self-consistent natural philosophy, can arrive at such reveries as that creatures might be at one time animal and at another time plant. Were that possible, it would have to be far easier still for a being to be at one moment fish and at another bird, or now beetle and now rose, and thereupon all our natural science would be folly, and we should do better to plant potatoes and eat them, though even then we could not be certain that they would not turn into mice and run away."

Against this I should like to recall a saying of Grabbe, overbold to be sure, yet apt from a certain point of view, which occurs in one of his dramas: "the devil stands nearer to God than the mite," the approximate equivalent of which is: an angel can more easily transform itself into a devil than into

a mole. What may be said with a degree of truth of the extremes of the highest development in two opposing kingdoms will, in consideration of their greater simplicity, hold good all the more for the extremes of the lowest development; these will stand nearer to one another and be capable of passing into one another more readily than the extremes of the lowest and the highest development within each kingdom taken by itself.

The facts themselves that are here at issue are as follows:

That certain algae (the simplest of aquatic plants) can pass over into infusoria, and conversely, has indeed been asserted many times before and always called into question again; yet there are now such careful and trustworthy observations on the matter, notably by Flotow and Kützing, that the advantage at the present time certainly no longer lies with the opponents. Yet there always remains, of course, the expedient (adopted by Flotow) of declaring the small animalcules to be plants for the very reason that they transform themselves into plants or arise from them.

The tiny vesicles composing the red-colouring matter of snow (Protococcus nivalis) were regarded by the first observers of the same (Agardh, Decandolle, Hooker, Unger, Martius, Harvey, Ehrenberg) as microscopic plants (algae); Ehrenberg even succeeded in observing the reproduction of these little plants, which originate in the Alps, in Berlin, by sowing the specimens that had been sent to him upon snow in the winter of 1838. The little plants multiplied in countless numbers, appeared perfectly identical to the parent corpuscles, were in their youth not red but green (a phenomenon

observable in many red-coloured algae), and bore not a trace of animal character, though they did bear a finely granular, lobed germinal bed and rootlets, which led Ehrenberg to include them among the algae under the name Sphaerella nivalis. Meanwhile, other observers, such as Voigt and Meyen, found that this red-colouring matter presented rather the forms and movements of infusoria, and declared it accordingly to be of animal nature. Shuttleworth, finally, distinguished within it partly infusoria and partly algae. These contradictions, which seemed to suggest that the observers had different materials before them, are resolved, however, by the very careful observations that Flotow made upon a little plant or animalcule, Haematococcus pluvialis, closely related to the red-colouring matter of snow, yet found not upon snow but in rainwater. This organism, consisting of microscopic, extremely delicate, spherical, gleaming, red vesicles, at first betrayed a purely plant-like nature, but under suitable circumstances in infusions transformed itself, through various intermediate forms that could be distinctly followed, into an infusory animalcule (Astasia pluvialis) with a proboscis-like appendage (occasionally even forked) and with all the signs of voluntary movement; on the strength of which there is reason to regard also the plant-like and animal-like states of the red-colouring matter of snow as no more than different stages of development of one and the same creature (all the more so as Flotow's Astasia pluvialis proves to be related to Shuttleworth's Astasia nivalis in the red snow). Since Flotow holds it as established that "the Haematococcus can only be either entirely animal or entirely plant," he is of the opinion,

to be sure, that the moving H. "has merely assumed the semblance of an Astasia," notwithstanding that he himself concedes the wholly animal character of its movements. (Nov. act. acad. Leop. Car. 1843. T. XX. p. 413.)

From Kützing's observations it emerges that the infusorium Chlamidomonas pulvisculus is capable of the most manifold transformations — that from it there develops a determinate algal species, Stygeoclonium stellare, and that still other formations arise from it which likewise bear a decided algal character, although in part they may also be claimed, by reason of their outward form, as resting infusorial states. (For Tetraspora lubrica or gelatinosa, Palmella botryoides, and species of Protococcus and Urges appear as various developmental forms.) According to the same authority, the infusorium Enchelys pulvisculus transforms itself into a Protococcus and ultimately into an Oscillatoria. (Kützing, Über die Verwandlung der Infusorien in niedere Algenformen. Nordhausen. 1844.)

In a whole series of algae (Zoospermae), both articulated and unarticulated, as well as in other lower plants (fungi, Nostoc), it has been observed that their germinal bodies (spores, sporidia, called seeds by some), bursting forth from the mother plant, for a time perform in water a movement that appears spontaneous and resembles that of infusoria — indeed, among them one may recognise in part forms which Ehrenberg has actually described as infusoria — and that they then settle, after perhaps a couple of hours, and begin to germinate, so that a plant like the mother plant arises from them. These germinal bodies exhibit, to be sure, no animal

organisation internally, but they do externally, inasmuch as one may observe upon them organs resembling cilia or whip-like appendages similar to those which elsewhere play so great a role in the movements of lower animals, and in particular of many recognised infusoria.

How remarkable these phenomena appear may be gathered from the following passage in Unger's treatise, "Die Pflanze im Moment der Tierwerdung." After describing in letters to a friend the phenomena of Vaucheria clavata up to the emergence of the sporidia, he writes (p. 21): "If you have followed me thus far, you cannot possibly have held your expectations at so high a pitch that what I am about to tell you further would not surpass even the boldest flight of the imagination. Indeed, it is truly a wonder, a phenomenon so far removed from the general laws of nature, that one might suppose nature has here allowed herself a poetic licence rather than drawn back, for once, the veil from a process which she perhaps practises and still practises daily and hourly a million times over with the slightest modification: — Deep and earnest is the significance of generation in each of its individual steps, but truly wondrous may it be called when the generated thing is other than the generator, when, in short, the natures of both are different, as is precisely the case here.

All the more interesting do these phenomena become when one compares them with wholly analogous occurrences that fall within the recognised animal kingdom. The eggs (more properly called embryos, according to more recent views) of many, and in all probability all, of those lower animals which, on account of their sessile habit and plant-like

mode of growth, are called in a wider sense zoophytes, possess an organisation of an entirely similar simple kind as those germinal bodies of the algae; they likewise move freely for a time with ciliary organs in the water and only settle afterwards, in order to continue growing in a plant-like manner. The most perfect analogy obtains between algae and zoophytes in this respect. Indeed even in somewhat more highly organised animals, similar conditions occur within certain limits.

Of the numerous observations and reports upon this subject I shall allow some of the most reliable to follow.

The small alga Vaucheria clavata Agdh. (Ectosperma clavata Vauch.), gathered in numerous individuals, covers in the form of small cushion-like tufts the surface of stones in the shallow and swiftly flowing waters of central Europe. In its developed state it presents a branched, unarticulated tube of one ten-thousandth of a Viennese inch in diameter, which owes its green colour to the chlorophyll within. Under normal conditions, a transverse wall now appears at the tip of the terminal shoots within the originally simple tube, and within the upper compartment thereby formed, the formation proceeds from an uncoloured, mucilaginous-granular substance of a tube (sporidium) that moulds itself to the original membrane and is composed of a ciliated epithelium. In its interior only the faintest trace of organisation is discernible. Through the swelling of the ripening sporidia simultaneously with the thinning of the tip of the mother tube by resorption (extension), this tip bursts, and the sporidium presses itself through the narrow opening "of its own accord," and at last

even with a rotating movement. This process lasts a few minutes. The sporidia after emergence have a pear-shaped or egg-shaped form, which gradually changes into a regularly oval or ellipsoidal one. Freed from the mother tube, "it first raises itself in joyful rapid motion through the water and circles in various directions like an infusorium." The movement is one that rotates in a constant direction from left to right while simultaneously advancing. A uniformly ciliated epithelium covered with vibrating cilia produces it. If one introduces a little divided colouring matter into the water, one may see the vortex which the cilia create. Moments of rest alternate "at will" with movements, which last altogether for some two hours. Highly striking is the way in which the sporidia during these movements carefully avoid all obstacles, how skilfully they draw through the network of the shoots of the Vaucheria and evade one another, so that no collision or mutual impact ever occurs. Rather more or less rounded mucilaginous granules, coated with chlorophyll, distributed somewhat irregularly, and lying much more densely in the hinder than in the forward part, are the only bodies with certainty recognisable which have an essential share in the internal constitution of the sporidia. With the cessation of movement the ellipsoid changes into the spherical form; all cilia disappear suddenly, without one's knowing whither they go; the green colouring is distributed more uniformly, and the glassy transparency of the epithelium is transformed into a delicate homogeneous plant membrane. In less than twelve hours the vesicle elongates itself by direct outgrowth at one or at two points simultaneously, and with this the phenomena of germination set

in. The development of the tubes proceeds rapidly. On one side a root-like formation is produced, by which the small plant attaches itself, while the other extension elongates, branches, and within fourteen days attains the like formation of spores. Warm water, even at twenty degrees Réaumur, acts lethally upon the motile sporidia; on the other hand, a temperature approaching the freezing point of water, while interrupting the movements and even the vegetative manifestations of life, does not kill them. Deprivation of light acts by accelerating the cessation of movement, and germination is prevented. The galvanic current exercises a similar influence as upon infusoria: a weak current produces stupefaction and irregularity of movement; a stronger one causes death immediately. Mineral acids, alkalis, and most salts act lethally in even the smallest quantities. When merrily swimming germs were placed in a concentrated solution of morphine sulphate, they did at first cease to move, but shortly afterwards they resumed their movements, dancing about however in such strange circles as if they were in a state of stupefaction, and after a few minutes repose ensued. Opium extract acted even more powerfully; the very smallest dose, dissolved in water, brought on paralysis of movement and death. In concentrated hydrocyanic acid diluted with equal parts of distilled water, the sporidia that were introduced, merrily swimming, became suddenly motionless. No absorption of colouring matter, such as occurs with infusoria, could be brought about by any means. (After Unger's treatise: Die Pflanze im Moment der Tierwerdung.)

Thuret has also, in the spores of Conferva glomerata and rivularis, Chaetophora elegans var. pisiformis, Prolifera rivularis and Candollii Leclerc, specially demonstrated the dependence of similar phenomena upon ciliary or whip-like organs. (Ann. des sc. nat. 2nd ser. vol. XIX.)

Achlya prolifera (a gelatinous alga) possesses two kinds of spores: larger ones, which are formed in smaller number within spherical sporangia, and smaller ones, which develop in greater number within the unaltered filiform terminal members. At the time of spore maturity a small operculum separates from the terminal members; shortly before this the spores fall into a swarming

Movement, during which a real, often considerable change of position takes place. This movement continues for a time after the exit and finally ceases, whereupon the spores frequently germinate within a few hours. When such a terminal member has been emptied, a new member of the same kind usually grows inward from the next partition, often not entirely filling the older one that remains standing. In this new member, too, spores again form, which upon their exit have two openings to pass through, and sometimes oscillate for a long while between both cell-walls before emerging through the second opening. It also happens, however, that they do not reach this second outlet at all, and at least begin the process of germination within the older sac. (Schleiden, Grundz. I. 264.)

"The embryos of Campanularia geniculata (Sertularia geniculata Müll.) are oblong, cylindrical or pear-shaped, sac-like bodies, completely enclosed by a delicate membrane,

without any oral opening and without the slightest trace of internal organisation. Their surface is covered with an extraordinary number of fine cilia, by means of which they are rendered capable of executing rapid movements, of swimming about like infusoria in water, and of seeking out those positions most suited to their further development. After this brief infusorial state they acquire a disc-like form, attach themselves to an object, and put forth a sac-like extension, which at first is not even distinguishable in form from that of germinating algal spores. With this, the animal enters only the second stage of its life — the polyp stage — in which the organs of reproduction are formed only gradually. Precisely the same holds true of the embryos of medusae, according to the observations of Ehrenberg, Siebold (Beitr. z. Naturgesch. der wirbellosen Tiere. Danzig. 1839), and above all those of M. Sars on Medusa aurita and Cyanea capillata (Arch. f. Naturgesch. 1841. p. 9). As soon as these leave the mother's arms, they are scarcely more than point-sized, oval or pear-shaped, slightly compressed little bodies, without any mouth opening and without any trace of internal organisation. Their body is soft, consisting merely of a very finely granular tissue, and appears to contain a large cavity internally, of the same form as that of the body's contour. Dense cilia cover the entire surface of the body uniformly and allow it to execute movements in every direction, after the manner of infusoria. In swimming, they frequently rotate about their longitudinal axis, the blunt end going foremost. Only after the period of their infusorial life has run its course do they attach themselves by their forward end, acquiring below a stalk-like ex-

tension, whilst on the opposite surface there appears a depression surrounded by tentacles, which expands into a mouth and stomach; and with this they become polyps, putting forth branches and reproducing both by means of these and by transverse division. Only the young arising through transverse division attain the form and organisation of acalephae. (Unger's work, p. 88.)

"The vorticella develops a stalk, divides (and moults?), develops dorsal cilia, detaches itself from the stalk, roams about, draws in the dorsal cilia again (after a second moult?) or loses them, and attaches itself once more in order to secrete another stalk, to form a genealogical tree, and to repeat the same process without cessation." (Ehrenberg, in his work on Infusoria, p. 290.)

According to Burmeister, the cirripeds, in particular the anatifers, possess at the time of hatching from the egg two muscleless feeler-threads furnished with suckers at the front, three pairs of legs terminating in bristles and in part forked laterally, and eyes consisting of a cornea, crystalline lens, and black pigment, and they swim freely about; but once they have attached themselves at a spot by means of their suckers, they grow fast by a fleshy stalk and shed with their skin both the feeler-threads and the eyes, whilst the pairs of legs double in number and are transformed into manifoldly pinnate, curved cirri. (Burmeister, Beiträge zur Geschichte der Rankenfüßer. Berlin. 1834.)

According to Nordmann, the female Lernaeocera cyprinacea, as it emerges from the egg, possesses the ordinary form of other crustacean parasites — namely, a pair of feeler-

threads, two pairs of feet, and a single eye; but once it has, with the aid of these organs, sought out a fish as its future dwelling and has deeply embedded its forepart in the flesh of that fish, its body is transformed, upon the disappearance of those organs, into a simple cylinder, in which one can no longer discern even muscles or nerves, whilst the digestive organs continue to develop and the generative organs form themselves. It then remains until its death in the hollow it has excavated, there to absorb nourishment from the flesh of the fish in plant-like fashion, and to produce offspring with the male, which appears to nourish itself on her excrement but otherwise retains its sensory and locomotive organs. (Nordmann, Mikrographische Beitr. z. Naturgesch. der wirbellosen Tiere. Berlin. 1830. Part II. p. 123 ff.)

Beyond such movements as merely denote a transitory developmental state of certain lower plant-organisms, there occur also all manner of remarkable phenomena of movement, of varied and insufficiently understood significance, in developed lower plant-organisms themselves, which may call to mind animal phenomena and in some instances even give one pause as to whether one should not rather speak here of an animal than of a plant.

"Most striking are the phenomena presented by the oscillatoria, a small genus of algae (regarded by others as being of animal nature rather than plant). They appear as short filaments, composed of cylindrical cells broader than they are long, joined one to another, filled with green matter and with contents of various kinds, partly fluid, partly granular. The tip of each filament is somewhat tapered and rounded, frequently

water-clear and colourless. So long as they vegetate with vigour, these filaments display a threefold movement: an alternating slight curvature of the anterior end, a half-pendulum-like, half-elastic back-and-forth bending of the anterior half, and a gradual forward advance. These movements are often observed all simultaneously, often individually. They have (says Schleiden) something strange, I might say uncanny, about them." (Schleiden, Grundz. II. 549.) If oscillatoria are enclosed in a dark space and light is admitted through an opening, all the oscillatoria draw towards the opening and vanish from the rest of the dark interior of the vessel. (Vaucher, Hist. des conf. d'eau douce. 171.) For further particulars concerning the movements of the oscillatoria, see Meyen's Physiol. III. 443.

"If fragments of the slimy substance are torn from a sponge (reckoned by some among the animals), these, according to Dujardin, appear at first motionless under the microscope, but under suitable illumination one can discern at their margins rounded, transparent protuberances which alter their form at every instant through expansion and contraction. At times, indeed, small fragments of from one-hundredth to one-two-hundredth of a millimetre in length are said to move slowly, creeping along the glass by means of such extensions. Dujardin claims to have observed this phenomenon in Spongia panicea, Cliona celata, and Spongilla since 1835. He also observed at the margins of torn-off lobes of Spongilla threads of extraordinary delicacy protruding and swinging with vivid undulating motion, so that in small isolated masses they occasioned a locomotion different from that

described above." Against the animal nature of the spongillae thereby suggested, there speak, apart from the absence of a stomach, the observations of Hogg, to the effect that the spongilla maintains its green colour solely through the influence of light and loses it again when deprived of that influence, develops gas in the light, behaves towards acids in a manner analogous to plants, and so forth. (Wiegm. Arch. 1839. II. p. 197. 1841. II. p. 410.)

In the mosses, liverworts, stoneworts, and ferns, spiral threads develop within the cells of their so-called antheridia or anthers (whose significance as such is, however, disputed) — one in each cell, and according to Thuret, in the case of stoneworts occasionally two — which, when the cells come into contact with water, execute a lively rotatory movement about their axis, and which, even after the rupture of the little cell, continue this movement for a time independently in the water, advancing as they do so. These spiral threads have been compared with the so-called spermatozoa of animals — with some observers even believing they could discern bristles or tactile tips upon them — without, however, any sufficient ground for attributing to them an identical function. For further detail, see Meyen, Physiol. III, pp. 208ff.; Schleiden, Grundz. II, pp. 48, 66, 77; Wiegm. Arch. 1837, I, p. 430; 1838, I, p. 212; II, p. 85; 1839, II, p. 45; 1841, II, p. 423.

The molecular movements executed by the globules of pollen-contents after their emergence appear, according to more recent investigations, not to merit the interest formerly inclined to be attributed to them. (Cf. Schleiden, Grundz. II, p. 303.)

In the majority of plants belonging to the families of the Characeae, Najadaceae, and Hydrocharitaceae, and in the fruit-stalks of the Jungermanniaceae, a simple current is observable within each cell, ascending on one side and descending on the other, consisting of a fluid distinguished from the remaining clear cell-sap by its colour, consistency (viscosity), and insolubility in aqueous liquids. In certain plants this current is rendered especially visible by the fact that it carries along the globules suspended within the sap — starch, chlorophyll, mucilage, and the like — though in most cases it is also discernible with sufficient clarity on its own account. (For further detail, see Schleiden, Grundz. II, p. 256.)

XIII. Unity and Centralisation of the Plant Organism

XIII. Einheit und Zentralisation des Pflanzenorganismus.

"Each cell," says Schleiden, "nourishes itself independently and in a manner peculiar to its own nature." (Schleiden, Grundz. II. p. 464.)

"Given the independence of the life of individual cells, processes may occur in and around particular cells which are of no significance whatsoever for the life of neighbouring cells, and thus for the life of the plant as a whole." (Ibid. II. p. 464.)

"The nourishment of the whole plant consists merely in the nourishment of its individual cells." (p. 466.)

"The plant, as such, consists essentially only in the morphological interconnection of its physiologically independent elementary organs." (p. 470.)

"We may regard the cell as a small, independent organism, living for itself. From its surroundings it absorbs liquid nourishment, and from this it forms, through chemical processes that are perpetually active within the cell's interior, new substances... In the busy play of the absorption and secretion of substances, of the chemical formation, transformation, and decomposition of substances, consists the entire life of the cell and — since the plant is in truth nothing other than the sum of many cells united into a determinate form — also the life of the whole plant." (Schleiden, Die Pflanze. p. 41.)

"Each individual cell leads, as it were, a separate life for itself." (Ibid. p. 47.)

Could one say more plainly than we here hear from an expert: that the plant, considered as a whole, is nothing, and the cell is everything? To be sure, we call the plant organic and living, and rightly so; yet it is so only as a part belonging to the whole of the natural organism, absorbed into that whole. It has grown out of the soil, still rooted in it as a hair upon our head; its processes, though more active than those of the hair, are no different in kind from those of a gland within our body, wherein manifold substances are worked up for the purposes of the whole. So too in the plant, air, light, and solid matter from the outer world are elaborated in a peculiar manner for the purposes of the whole. Who would seek a soul of its own in a little lobe of the liver? Is there any greater reason to seek one in the plant? Let the plant, then, by all means be called organic and living; let even an idea be supposed to underlie its creation and formation; but if it is not, after all, an organic entity that closes upon itself, a living being that moves in its own circle and refers back to itself, then the idea underlying its being and life cannot be sought in a principle of soul immanent to the plant itself. The divine spirit may, in the fullness of its world of ideas, carry within itself the idea of plant form as a living thing; yet it is only His life, His idea — not a life of its own, not a soul of its own — that is given to the plant.

How utterly different is all this in the case of animals! The animal organism closes itself roundly upon itself, stands upon its own foundation, moves in its own circle, referring at every

turn back to itself. Nothing can be torn away and planted independently, and wherever and however something is severed, the whole feels it. Whole and individual exist only with and through one another, as they are. As each acts upon every other, so each acts, through the mediation of the others and within the circle of their relations, back upon itself. Wherever the governing centre may lie — even should it lie at no single determinate point — it is assuredly present and manifest in the effects, something that binds the whole together and compels all things to submit to it.

I have sought to exhaust everything that can be said in this vein; indeed, were I to know of anything still more forcible that could be said in this sense, I should gladly have said it, for it is not my wish to evade objections but to meet them. Perhaps, however, I have already said more than many will themselves be willing to say; what exceeds the mark need only be subtracted. If the objection has not been set forth and developed with entire cogency and clarity, the fault may not be ours; for when one attempts to reduce it to what is cogent and clear, it dissolves of its own accord. Why raise it at all, then? Because it is raised at all.

In order to present the very words of an opponent, I cite the following argument by Carus (Psyche, p. 112), which is framed principally in the spirit of the foregoing objection, though it touches in part upon matters already considered elsewhere.

"The plant kingdom, throughout its entirety — both in each individual plant and in the manifold variety of its forms — rests essentially upon the endless repetition of a single

fundamental form; it is, through and through, cellular construction repeating itself to infinity, and for this reason capable of reproducing the whole from every single cell, ever and again; and precisely for this reason also never fully completing the concept of totality. Even the layman, without being conscious of the deeper grounds for it, therefore separates parts from a plant with feelings and thoughts altogether different from those he would bring to an animal: he will always regard the former, in a sense, as a fragment, and the latter always as a whole. To break off a leaf or a flower is done with pleasure; to detach a limb from a living animal will be painful to him every time. For the foregoing reason the plant has no viscera and no organs differentiated in the sense in which those of an animal are — it is therefore impossible that, in contrast to organs that become essentially heterogeneous, such a primordial structure as the nervous system should remain; in short, the plant remains essentially always only a plurality of units, it lacks such an inner centre as the animal possesses, and although it too cannot exist without a certain totality, that concept is never so completely closed as in the animal kingdom. From this it follows, first, that the concept of higher and lower organisation, which declares itself so plainly in the animal kingdom, can in the plant kingdom only very imperfectly express itself — it will always remain a matter of dispute which plant is to be regarded as the highest; and it follows, secondly, that since the plant lacks a truly central system, and therewith a perfect bond of unity and wholeness, no kind of consciousness whatsoever can as yet be spoken of here. If, accordingly, we are accustomed to designate

by the name of soul only that idea in which some form of consciousness has actually developed, it follows clearly from the above that it cannot yet be affirmed of the plant that a soul has been given to it."

On closer inspection it becomes apparent that the foregoing objection demands of the plant, as conditions for the possession of a soul, things that are not universally found even in animals, or are found only in appearance, and which there is no intrinsic reason to require as essential to the existence of a soul — while at the same time it misses things that are at bottom to be found in plants just as much as in animals, though in another form.

The animal is, to begin with, just as much as the plant a mass of externally interconnected cells. It is well known that even nerve and muscle fibres consist of cells laid together and in part fused with one another, and in this respect the closest possible analogy between plants and animals has been found. Where, then, within this mass of cells in the animal, is the central point that one demands of the plant? In the brain? But the brain is merely a tissue of fibres running alongside and between one another; nowhere is there a single point in which they converge. Or is the whole brain itself this central point? That is the common opinion, though it is somewhat large for a point — an objection that one does not allow to trouble oneself. Yet there exist enough animals which, instead of a brain, possess only scattered ganglionic nodes, albeit connected by nerves, and which nevertheless betray, in highly developed and purposively ordered instincts, the governance of a soul unified within itself. Insects are indeed cred-

ited with a brain; it is a nerve-node situated in the head from which the chief sensory nerves issue; yet it is often smaller than other nerve-nodes of the same insect, and when it is removed together with the head, the signs of psychic activity do not cease.

Let one hear:

The arthropods (insects) continue to exhibit movements after decapitation that presuppose the activity of will. Decapitated flies and beetles often fly and walk for a considerable distance and duration following the operation. They move not merely in response to external stimuli, but alternate between movement and rest in a manner that follows no fixed pattern, and the repose does not appear to be a simple consequence of fatigue. A decapitated blowfly was found to be sensitive to tobacco smoke, though this need not necessarily be attributed to any faculty of smell. When placed on its back, it endeavoured to right itself, and when a pointed stick was held out to assist it — since it could not succeed unaided — it first seized the stick with one foot and then deftly drew up the remaining legs. Decapitated wasps sting in a manner that scarcely allows one to mistake their striving to sting: the sting is not thrust forward and withdrawn in a purely mechanical fashion, but rather the animal seizes hold of an object with its feet, holds it firmly, and then stings into it. Treviranus observed similar phenomena. Such movements are not reflex movements, for they occur without external stimulus; nor do they bear much resemblance to convulsions, as Grainger interprets them. For on the one hand they lack the twitching quality characteristic of convulsions, and on the

other they appear to pursue purposes that are given by representation. (Volkmann in Wagner's Physiological Dictionary, article "Brain," p. 576.)

The nervous system of the Asterias consists of a nerve-ring in which five ganglia are symmetrically distributed, each of equal value to the others; yet this creature moves with all the signs of psychic unity just as well as one possessing a single principal central organ.

Now I maintain: if the unity of the soul is compatible with a distribution across five ganglia, it is equally compatible with a distribution across a hundred or a thousand ganglia, and, where nerves are not necessary at all, with a distribution across millions of cells. We see plainly that the degree of centralisation demanded by those objections is simply not relevant. Undeniably the massing together of nervous substance in the human brain has its great significance, but that significance must be of a different kind than the conditioning of the unity of the soul.

Since the brain will not serve the purpose, one proceeds further and seeks (as Carus does) the expression of a unifying, centralising unity in the nervous system as a whole. Yet it is surely evident that if one denies plants such a unity on the grounds that they are mere agglomerates of cells, one cannot then discover the expression of such unity in a system that is itself equally a mere agglomerate of fibres. Only insofar as the nervous system itself offered a central point would the animal possess therein something that centralises; but this is not the case. Besides, if the only concern is the contrast between a system more inwardly situated and systems more outwardly

situated within the organisation, one may find even in the spiral fibres of plants something that holds a central position relative to the other structural elements of the plant; and if no spiral fibres have hitherto been found in the simplest plants, this corresponds only to the fact that no nerves have yet been found in the simplest animals either. We have already remarked previously on the great degree of analogy that the spiral fibres in general bear to nerve fibres, yet we are no more inclined here than we were there to place greater weight upon this analogy, because we regard the entire demand for a central system or central organ as a condition of ensoulment as unwarranted.

Perhaps the most striking example that neither a central organ, nor a circulatory current of fluids returning upon itself, is essentially necessary as the bearer, expression, or condition of the unity, the sovereignty, and the self-containment of the soul, may once again be furnished by the polyp. Let us recall certain facts already cited earlier. When a sea-anemone has fully extended itself with all its tentacles spread wide, and one touches it with a needle or agitates the water, it contracts all at once, in every part, into a small compact mass. This presents itself entirely as the effect of a soul that governs the whole body of the polyp and binds all its parts in a unified nexus of action, a conclusion one may connect with the other signs, cited above, of the peculiar and purposively coherent psychic activities of the polyp. Now I do not at all assert that polyps are philosophers; but I do assert that he himself is a poor philosopher who, in the face of such signs, would deny to the polyp definite, autonomous, and unitedly connected

sensations and impulses of various kinds. And what is the polyp in terms of its organisation? A simple tube, in which neither vessels nor nerves have as yet been discovered with any certainty, furnished at one end with hollow tentacles. One may still perhaps discover nerves, or find that what has been taken as such in certain species truly deserves the name; but a central organ and a circulation will assuredly not be discovered. If, however, so much autonomous and internally coherent sensation and volition can exist without a central organ and circulation, then still more can exist without them, since sensation and volition are in that case not bound to those conditions at all.

Is it not remarkable that, while the soul is commonly regarded as the very principle that binds together the entire multiplicity of the corporeal, one is nevertheless so inclined to demand, as a special expression of its unifying power, the visible emergence of some distinguished point or organ within that multiplicity? Let us consider the figure in a kaleidoscope: every ray of the coloured star is there of equal value to every other; in the acanthus leaf of the Corinthian capital likewise, each lateral leaflet counts for as much as its neighbour; there is no part that specially represents the unifying idea which, given the harmonious impression of the whole, must nonetheless be present; it is grounded in the symmetry that binds the whole together. As little as a tangible proof of the unifying force of an idea can be demanded in any single specially distinguished part of an object, so little can such proof be demanded of the soul of a subject. It is true that in the coloured star of the kaleidoscope one may point to the

midpoint, and in the acanthus leaf to the axis of the leaf, as the unifying element; but such an ideal centre is not lacking in the plant either, whether one points to the nodal point from which the root descends and the stem ascends, or to the axis of the whole plant, whose normative significance is in any case so much remarked upon in botany.

I conceive it to be with the body as with the world. God reigns as omnipresent throughout the whole world, binding and connecting all things, without requiring for this purpose a central sun appearing at the midpoint; one can only conceive of an ideal centre of force, a centre of gravity, for the whole, which might equally fall into the void between the suns as into one of them, and which would be equally discoverable were all the suns perfectly equal. Only insofar as they are in truth not perfectly equal does the larger and weightier sun signify more and something of greater import than the smaller and lighter one. So likewise in our lesser body it is no single organ upon whose existence the sovereignty and unifying force of the soul depends; it reigns as omnipresent in the body as God reigns in the world. And when in a given body certain parts acquire greater significance than others, a supremacy over the rest, this too can only signify a higher development of the soul beyond the condition in which all is equal, but cannot first signify the existence of the soul itself; and even in the plant there is no lack of such parts, whether we attend inwardly to the spiral vessels or outwardly to the blossom, which, though it is not present from the beginning, is yet from the beginning in the process of becoming, and in this becoming already imparts its direction to the whole life-

process of the plant. Indeed this direction, which all parts and aspects of the life-process of the plant take from the very beginning toward the production of the blossom, affords in itself the best proof of the futility of all those assertions that the plant is nothing but a heap of cells standing in no relation to one another. It would be as though a beautiful dome could bloom of itself from a heap of sand and stone.

It is, admittedly, all too common to conceive of the soul itself as a kind of small corporeal being dwelling within the larger corporeal structure, in which case it would of course also require a special small

need no little chair of its own to sit in, from which it might govern the whole of the body and have whatever it requires carried thither. One imagines the soul rather as the queen of a beehive, residing in some especially distinguished chamber of the hive, around which the entire household of the hive revolves. But if we hold fast to this image, the soul of the beehive does not in truth reside solely in the queen; for what would a beehive be if it contained nothing but a queen? She is merely the principal thing within it. In every cell where a bee sits, something of the soul of the beehive likewise sits. And while in the beehive the queen does indeed distinguish herself above all other bees, as our brain, or some portion thereof, distinguishes itself above all other organs, this is no longer the case in the anthill, where matters nevertheless proceed with no less unity and order than in the beehive. Well then, I say: if animals are monarchical beehives, plants are republican anthills. Yet a republic has its unity just as surely as a monarchy.

It is true that in a monarchy the unifying principle seems to us more firmly secured and more strictly represented than in a republic. But upon what does this depend? Surely only upon the fact that every human being already constitutes in himself a monarchical system with the brain at its head; and accordingly a human society is also more disposed to close itself into a perfect unity under a monarchy than under a republic. But the ants demonstrate that this has nothing whatsoever to do with the nature of a republic in itself. And one cannot see why it should be harder for nature to locate an ideal unity within a mass of fused cells than within a mass of dispersed, individually moving ants.

After all that has been said, in inquiring into the external expression or the bodily conditions of the unity of the soul in the plant, one need take no account whatsoever of whether something in the plant clumps together in a fashion analogous to the brain in the animal, or assumes a similarly central position relative to the rest of the body as the nervous system does; for that clump and that system are, on closer inspection, still as highly composite as the cellular structure of the plant itself, and as we have seen, not even every animal contains such a clump, and the knot of the ideal connection is in no case to be found in any massive node or central strand. A network with many nodes can serve as a carrier of psychic unity just as well as a single cord in which many threads converge at one point.

On the other hand, one will certainly be required to demand, as the expression of a unifying and self-referential dominion of the soul, a thoroughgoing mutual correspondence

among all parts and activities of the corporeal organism, and their harmonious cooperation toward purposeful achievements for the individual. For it is precisely this that we perceive in human beings and animals as the expression of the unifying sovereignty of the soul. Let us now examine whether it is lacking in plants. As regards the aspect of purposiveness, enough has already been said on this subject in what preceded. But the existence of a thoroughgoing mutual relation still requires its demonstration against the assertions advanced above.

One is in the first place greatly mistaken if one supposes that the outward form of the plant, which encompasses the entire cellular structure according to a unified plan, is a mere externality that deserves no consideration when the question arises whether a living inner mutual correspondence exists among the forces and activities of all the individual cells; for that external form is itself nothing other than the outwardly manifest effect of the internally coherent working of the totality of all cells, and could not otherwise have come into being in the manner in which it has indeed come into being. If a tulip bulb beneath the earth has never yet borne anything other than a tulip above the earth, who can deny that the forces which form the plant below the earth work in the closest connection with those which form it above the earth, and that the cells of the bulb and of the tulip are, in their arrangement and function, mutually dependent upon one another?

In declaring the plant to be essentially nothing more than a morphological linkage of its physiologically autonomous elementary organs, one commits in truth nothing other than a

contradictio in adjecto. And who will really believe what one would be obliged to believe on this account, namely that a cell which, in the context of the whole plant, produces for instance starch or sugar, and reproduces in its own particular manner, would be equally capable of doing so outside of that context? If there are plants consisting of but a single cell, such as Protococcus, which are still capable of vegetating, and upon which much weight appears to be placed, it would follow neither logically nor empirically from the fact that a plant cell can exist independently, because it happens in one particular case to be constituted for that purpose, that plant cells, even where they no longer stand alone, still exist and can exist independently of themselves, while direct experience shows rather that they cannot.

Were it indeed true that one could detach parts of a plant without thereby altering anything in the remainder of the plant, this might afford a direct proof against the mutual dependence of the various parts of the plant and their functions upon one another; but on closer examination, experience teaches precisely the opposite. Who is not acquainted with the pruning of vines, the pruning of trees? If I cut away a branch here, a new one shoots forth from a bud that would otherwise have produced none. If I strip a tree of all its leaves, the trunk and roots may under certain circumstances perish; if I cut away the roots, the trunk, branches and leaves perish, though sometimes they do not; new roots shoot out that would otherwise have put forth none. It is as with the lizard from which one cuts away a limb: if it has one, it does not grow another; if it has none, it grows one. That one does

not notice the influence of small injuries upon the plant is of course natural enough; but it does not therefore fail to exist. For just as certainly as a tree feels a considerable change when all its leaves are taken from it, so certainly must it feel a proportionally smaller change when but one is taken.

Here follows a series of facts serving to illustrate, under various forms, the thoroughgoing mutual correspondence that prevails throughout the parts of the plant from below upward as from above downward, and from the axis toward the lateral parts and back again.

Schleiden writes (Grundz., Vol. I, p. 218): "We observe readily that in the individual cells of the Chara the oblique direction of the green spherules completes itself through the succeeding cells into a perfect spiral; likewise there frequently exists a peculiar correspondence between the spiral depositions of two neighbouring cells, such that to the not very attentive observer the spiral appears to continue without interruption." This fact would seem not to be entirely reconcilable with the foregoing assertions of Schleiden himself.

Linné observed that a tree overfed in a wider vessel produced several years in succession branches out of branches, while the same tree, confined within a narrower vessel, quickly bore flowers and fruit. Here one recognises the influence which the nature of the root system exerts upon the crown of the tree.

Knight observed that all pear and apple trees that had been stripped of the outer portions of their bark put on more wood in two years than they had put on in the preceding

twenty (Decand., Vol. II, p. 812). Here the influence of an alteration in the outer parts upon the inner parts reveals itself.

If one removes from the circumference of a branch or tree a ring-shaped strip of bark, a so-called magic ring, it bears more abundantly in the part above in flowers and fruit, ripens the latter more quickly, sheds its leaves earlier, and increases more strongly in woody substance above than below that incision (Schleiden, Grundz., Vol. II, p. 503). Here the influence of a change produced at a single small point upon the entire vegetation of the tree becomes manifest.

When a graft, for instance of apricot, is set upon a plum stock, the plum stock gradually clothes itself with annual rings of apricot wood (ibid., p. 803). Here one sees plainly how not only changes made below act upward, but changes made above act downward as well.

In winter, if one takes a tree that stands with its roots in the earth or in a vessel containing water only a few degrees above freezing, and brings one of its branches — without severing it from the trunk, which remains in the cold — into a forcing-house warmed to 12° or 15° (C.?), that branch will put forth its leaves and blossoms, while the remainder of the tree, still standing in the cold, appears entirely dormant. (Decand., Phys. I. p. 76.) Here one observes that the increased activity induced by the warmth in the branches has in turn stimulated the absorptive activity of the roots to supply sap for the forcing of the branch: "for," says Decandolle, "the water that develops these buds does not come from the forcing-house in which they live, but from the earth or the water surrounding the roots; I have myself been convinced of this by

observing that the water in the vessels into which the roots are immersed diminishes in quantity. Knight arrived at the same conclusion by remarking that, under the described circumstances, the trunk freezes more readily than usual. This more ready freezing demonstrates, namely, that the trunk below the portion introduced into the forcing-house contains more water than it ordinarily would."

If in May or June one strips a tree of its leaves, all the buds lying in their axils develop at once, as may be observed in mulberry trees stripped of leaves for the silkworms, and likewise when, after a hailstorm that has beaten all the leaves from the orchards, warm and humid weather sets in. (Decand. II. p. 482.) When too many branches stand crowded together, the weaker are starved out by the stronger; when too many fruits spring up in close proximity, only those whose growth is most vigorous thrive, while the rest perish. (Ibid. p. 484.) — During the development of new leaves, the movements of plant-sleep in the immediately neighbouring leaves become very irregular and sluggish, as is also the case in certain plants (e.g. Lupinus) at the time of the development of flowers and fruits. (Dassen in Wiegm. Arch. 1838. I. p. 216.) — In these instances one discerns a relation between neighbouring lateral parts of the same plant.

An observation that has often been made is repeated in the Compt. rend. 1835. II. 360 by Jaubert, namely that on the side where the branches of a tree are strongest, strong roots are likewise to be found. He states that he has encountered this very frequently in the Sologne when grubbing up trees. — Here there is a particular relationship between certain

parts of the tree and certain other parts of the same tree, just as such particular correspondences occur abundantly in animals as well.

Mustel affirms from his own experience that all the remaining parts of the flower wither as soon as one cuts away the petals when a flower is just beginning to open; if, on the other hand, the petals are removed at a later stage, the embryo seems only to gain the more. — In this single example one finds both sympathy and antagonism. (Mustel, Traite de la veget. I. 178.)

According to Gärtner (Vers. und Beobacht. über die Befruchtungsorgane der vollk. Gewächse. 1844.), when the fertilisation of the ovarium has not taken effect, the calyx withers and assumes a sickly appearance; but when fertilisation of the ovarium has taken place, it persists for several days, according to the nature of the plant. — Here a similar sympathy manifests itself in the opposite direction.

It has been uniformly observed that vines bearing blue grapes acquire deep crimson leaves in autumn, while those bearing white or yellow grapes assume yellow ones. (Decand. II. p. 707.) — Here one perceives how the colouring of the parts of a plant proceeds according to a coherent plan pervading the whole.

After such facts as these, one will assuredly be unable to deny that the plant is an individual bound firmly within itself through the mutual correspondence of all its parts, no less than the animal.

When we speak of a pervasive mutual relationship among all parts of the plant, we must of course not understand this

as though the cells at the root-tip were capable of exerting a direct action at a distance upon the cells of the blossom. No — their connection comes about only by means of the other cells of the plant, precisely as is the case in man and animal alike. The parts of my foot and of my head also act upon one another only through the mediation of the other parts; and herein there are relations more proximate and more remote.

We know the forces that mediate these relations as incompletely in the animal as in the plant; but their actual existence is in any case just as manifest in the plant as in the animal.

Certain mediating links are, nevertheless, genuinely accessible to our knowledge; only one must not seek to see the whole in them, but only moments of the whole. I would call to mind the following: in proportion as moisture is lost above through the transpiration of the plant, it must press upward from below, just as oil rises from below into the wick in proportion as it is consumed above. If a cell or fibre swells anywhere, it must act by pressure upon the entire remaining system; if a passage is obstructed anywhere, the sap will seek to force its way through the rest of the system; if a part is torn away, the sap will accrue in greater measure to the benefit of the remaining parts. The laws of exosmosis and endosmosis may extend their reach yet further here than we are aware. — One might ask what significance such hydrostatic and hydrodynamic processes can possibly hold for the psychical life. But when we observe that according as the blood flows more swiftly or more slowly or otherwise in our head and body — even by virtue of purely mechanical disturbances in the vascular system — the course of thought and the states of mood

can undergo the most important influence, and when its flow is arrested, come to a standstill; then we shall be well able to attribute to the mechanical aspects of sap-flow in plants a significance for the psychical life as well; it always remaining permissible to set the unfreedom of the mechanical in relation to the unfree side of the soul, since in truth that which in our thinking and feeling depends upon the mechanical side of the blood's movement within us is something wholly unfree in us.

What has been said above does not prevent each cell of the plant from leading in a certain sense its own individual life. It is simply a life subordinated to a higher individuality. Goethe expresses himself with sufficient aptness on this point in his Metamorphosis of Plants: "Every living thing is not a single entity but a multitude; even insofar as it appears to us as an individual, it remains nonetheless an assemblage of living, self-sufficient beings that are equal in idea and disposition, yet may in appearance become equal or similar, unequal or dissimilar." One must only take care not to fix one's attention one-sidedly upon the phenomena of individual cell-life, as though a pervasive general connection of their activities were in any way thereby excluded.

To the pervasive vital mutual-relation of all parts of the plant, we shall have further to demand a continuous serial connection of the successive manifestations of the plant's life with one another, as the expression of a soul-unity that governs and binds together not only the spatial but also the temporal dimension of its being. Nor is this wanting. In truth, just as the blossom of every plant stands in mutually condi-

tioning relations of form and function with its root, so every earlier developmental state of the plant acts as a condition for every later one. The present state of the plant is, to employ a favoured word, sublated, so to speak, in the following one; that is, the present state does not endure, yet preserves itself through its effects in the state that follows. It is precisely as our present mental activities preserve themselves in their effects through those that follow, even where they do not resurface in conscious recollection. And inasmuch as mental activities are borne by bodily activities, the one is inseparable from the other.

Examples of this relation of succession from earlier to later processes in the plant lie in part already in what has been said above, since the relations of mutual correspondence and relations of succession in the organism in truth subsist only together and intertwined. I add only a few further remarks where the latter aspect of the relations comes more conspicuously into consideration.

To this category belong in particular the periodic phenomena of plant life, insofar as they are independent of the periodicity of external influences; for in such cases an earlier state appears as the ground for its own later recurrence.

"Nowhere," says Decandolle (Vol. II, p. 18), "does this consequence of periodicity, or of habit, express itself more decidedly than when plants of one hemisphere are naturalized in the opposite one. If our fruit trees are transplanted to the temperate regions of the southern hemisphere, they continue for some years to bloom at the time corresponding to our spring; the reverse occurs when certain trees of the southern

hemisphere are brought to Europe." "It is frequently the case that a tree which in one year bore very abundant fruit, or on which the fruit remained attached for a very long time, will bloom little or not at all in the following year. In southern Europe it has been observed that the olive harvest fails when the olives are left too long upon the trees; this circumstance is responsible for the fact that the olive tree bears fruit only every other year. If, on the other hand, the olives are gathered early, one may harvest them annually."

The phenomena of habituation, too, which have been observed in the sensitive plant and other plants, are to be counted among these (cf. p. 181). One consequence of this habituation is that the sensitive plant, though it folds its leaves at every disturbance when kept indoors, does not do so in the same manner in its natural state in the open air. Link remarks in this connection: "In the wind the leaves of this plant collapse, but raise themselves again notwithstanding the wind, and accustom themselves in the end so thoroughly to it that the wind no longer acts upon them."

If one misses in plants a circulation of the sap, then polyps and other animals possess such a circulation just as little, as has already been noted, and undoubtedly the same holds true here as with regard to the predominance of a central organ; it signifies only a particular manner in which the whole may be bound into unity, without being the sole such manner. The essential thing will always be, in place of a circular coursing of the sap, such a circle of relations that, just as the phenomena in the root exert influence upon those in leaf and blos-

som, so in turn the reverse likewise obtains. That this is indeed so, the examples cited above sufficiently demonstrate.

But, one asks, is it not possible to cut a plant into a hundred pieces, and each of those pieces, made into a cutting, will continue to grow? Can one perhaps divide the soul also into a hundred pieces? How is one to conceive of such a thing?

It is true, it is far easier in that case to suppose that the plant has no soul; in this way one avoids the difficulty of imagining how it then conducts itself at the moment of division. I maintain, however, that nature takes no account of our ease or difficulty in conceiving such things.

Can one not equally cut the polyp into a hundred pieces, each of which yields a new polyp? One will again say: what do you prove by the polyp, to which we ourselves scarcely concede a soul? And I will again recall its contraction upon contact with a needle's point, its voracity, its quarrelling over prey, its selection among foodstuffs, its sensitivity to light. But naturally, it is inconvenient for us to think of the polyp as ensouled; and so we prefer to overlook such things. Yet we are, fortunately, not confined to the polyp alone. An earthworm, too, may be cut into two pieces, each of which yields a new earthworm. How is one to conceive of that? The earthworm is an animal that already possesses a vascular and nervous system, developed digestive organs, and muscles. There are hundreds and thousands of other animals in which the same is found.

Even in these very days I read in Froriep and Schleiden's Notices the following more recent experiments conducted

with the Nais serpentina.

Schnetzler repeatedly cut individual animals of this species into three or four unequal pieces, and from these obtained almost invariably an equal number of living individuals. In a piece taken from the middle and consisting of three rings, he observed for several days all signs of life; the circulation of the blood continued, and with it respiration, "feeling," movement, and so forth. At the moment of severing, the muscles closed both the intestinal canal and the great vascular trunk, thus preventing the escape of the nutritive fluid; gradually the connections between the dorsal vessel and the ventral vein were re-established, and so by degrees the severed piece became a new individual. (Froriep and Schleiden's Notices, 1848, January, p. 35.) "From this," says Schnetzler, "the chemical and physical forces which condition the visible vital phenomena of the individual appear to possess equal energy in all the rings of a naiad, just as the whole family is generally distinguished by the absence of locality for the animal functions, so that an entire animal represents, in a certain sense, a heap of individuals in a latent state."

Thus a naturalist draws from those experiments the conclusion "that an entire animal represents, in a certain sense, a heap of individuals in a latent state," that is to say, in other words, that in this respect it closely resembles the plants. And yet the naiad moves, feeds, and lives with signs of independent sensation as unmistakable as those of an insect or a leech.

One may trace such things even upward as far as the insects, though less distinctly.

A wasp, cut through between thorax and abdomen and thereby divided into two halves, continues with its anterior part to walk, to bite, and to exhibit all the actions from which one may infer the presence of volition; yet the severed abdomen likewise writhes in manifold ways and, when touched, endeavours to inflict injury with a sting moved alternately in all directions; both halves, moreover, may continue to live for days. (Autenrieth, Views, p. 435.)

Now it is true that an animal of the higher classes can no longer be cut at will into two or more pieces in such a manner that it continues to live; yet birth is proof that it is capable of dividing itself of its own accord into several such pieces.

Among the lower animals, however, there are many which, while still remaining on the first stage of development, even divide themselves spontaneously in such a manner that they entirely vanish, dissolving into several new living individuals of a different developmental stage, which either remain grouped together and thus straightway form a colony (aggregated ascidians), or separate entirely from one another to live on in isolation (campanularians, medusae, and so forth).

One may find all this as difficult to explain as one will; but can one therefore say that the polyp, the earthworm, the naiad, the insect, the woman who gives birth to a child, and so on, are beings without a single unified soul? I maintain that this difficulty need not concern us here at all. We ask merely: can one ascribe to plants as much unity of soul as to animals in which it has never been doubted?

As it is with the phenomena of separation, so it is with the phenomena of coalescence, which one might urge in a similar sense against the soul of plants. Lower animals have been half severed and the halves of different individuals sewn together, and under suitable circumstances have been seen to grow together and to behave as a single individual. It might for the present be impossible to state how the soul comports itself in such a process. But since we hold such phenomena to prove nothing against the soul in animals, how shall we do so in the case of plants?

It is true that such things occur in the plant kingdom to a greater extent than in the animal kingdom; but this can only prove that nature has chosen to bring the relationships here in question to a preferential degree of development precisely in the constitution of plants, while the constitution of the animal kingdom is less and only proportionally suited thereto, even as in other respects it approaches more nearly to that of the plant kingdom. In any case, what we find of this kind in animals must suffice to guard us against the hasty conclusion that such things are incompatible with ensoulment. One might say that nature has set up the plant-like animals as signposts in precisely this regard.

If one says that the plant organism is to be regarded only as a member absorbed into the larger whole of the total organism, comparable to a gland which takes up the substances of the greater organism into which it enters, processes them within itself, and returns them, one fails to see what could be said in this respect of the plant that would not apply equally to the animal. To be sure, the animal is not rooted fast in the

earth, yet it is rooted just as necessarily in the external earthly world as the plant; for lift it into the empty space above the earth and the atmosphere, and it will perish even sooner than a plant torn up by its roots; nor is it

so well engaged in a constant reciprocal exchange of substances and activities with the external world as the plant. In general, however, it does not contradict the individuality of a being to appear simultaneously as a member of a more universal order of things.

XIV. Further Details on the Constitution of the Plant Soul

XIV. Näheres über die Konstitution der Pflanzenseele.

These indications tended toward ascribing to plants a richly developed sensory life — one even more developed than that of animals — while denying them any higher intellectual capacity.

Such a conception of the plant's soul-life admits, on first consideration, of various objections, and in its further elaboration, of various developments.

One might say: is not that which we declare to be the level of the plant below that of the animal, rather the level of the animal below that of man? The animal, when compared to man, is deprived of reason and understanding; what remains to it, then, but sensibility — the very same faculty we wish to allow the plant. And yet, according to our view, the plant is meant to complement the animal rather than to repeat it.

But the animal is in truth not so purely sensory a being as one is inclined to declare it. What animals lack in comparison with us is, to be sure, reason, self-consciousness, the capacity to grasp general relations in a spiritual synthesis, the ability to reflect upon themselves, to draw conscious conclusions; yet do they not possess memories of the past and anticipations of the future — which, even where they concern sensory matters, are themselves not sensory in nature, for the sensory is confined solely to the present? Who does not believe that a

cat, stealing toward the dovecote, forms beforehand some image of what it intends to do there, and recalls the doves it saw fly within? But if reason and self-reflection can wither away while the soul yet persists in vigour and vitality, why should not that retrospective and prospective faculty likewise? It is precisely through this that we arrive at the lowest conceivable level of consciousness. And if nature has, in the animals, represented the lower combined with the higher but without the highest, in manifold configurations and in the most diverse directions, it stands to reason that she will have reserved for herself a distinct kingdom for the independent representation of the lowest element in its own right. The systematics of nature appears to demand this independent cultivation; the comparative simplicity of plants suffices to fulfil it.

But, one objects, the very essence of soul-life consists precisely in bearing and positing within itself temporal relations both forward and backward; to abolish these is to abolish soul-life itself. A level of soul such as that upon which we wish to place the plants cannot, by the very nature of the soul, exist.

But here two things are being confused. It is true that every conscious anticipation and retrospection of time also implies temporal relations of the soul, but the converse does not hold — the soul does not require such anticipation and retrospection in order to manifest itself vitally in temporal relations.

Suppose a person swings himself to and fro: he thinks consciously neither of the past nor the coming movement, yet

he feels the motion of the swinging in an unconscious relation between before and after.

Another person's soul is rocked and borne upon the current of a melody. He thinks consciously neither of the tones that have passed nor of those yet to come; yet the continuous thread of a felt relation spins itself from the tones already heard, through the present, onward already in the direction of those that follow.

Could not, then, the soul-life of plants also flow along in such a current of sensory impressions, without carrying with it reflected images of what lies before or behind in time?

In our own case, to be sure, anticipatory or retrospective reflection may at any moment enter into such sensory play of the soul; but it need not. Why, then, should there not be beings in which it also cannot, given that there are already beings in which the still higher and more general survey — by means of which many memories are linked at once — recedes?

In short, when we ask what yet remains to be stripped away from the plant, after the animal has already stripped away reason, there is here something whose stripping away is even still necessary in order to allow the soul to present itself in its simplest, most unfolded form. And when we actually observe — as is indeed the case — that signs of anticipation and memory are absent from the plant, we have no reason, as is commonly done, to conclude that the soul itself is absent; rather, were those signs not missing, we should on the contrary be missing a possible level of soul-life.

That we have previously attributed instincts to plants does not contradict our present denial of any conscious anticipation of the future. For the instincts of men and animals, insofar as they are pure instincts, do indeed bear a relation to the future, yet contain nothing of a developed consciousness of the future toward which they are directed. Who would believe that a caterpillar spins itself in with any consciousness of the reason why nature ordains it to do so; that a newborn child, before it has tasted milk for the first time, has already formed a representation of the milk it craves, and of the movements it must make to obtain it? It is rather a presently felt need that impels it; nature has arranged things so, both inwardly and outwardly, psychically and physically, with respect to the child and its circumstances, that the child — without knowing how or by what means — is driven to precisely those actions which lead to the satisfaction of that need. Only after milk has once been enjoyed, after the action by which the end was attained has once been accomplished, will it be able to remember this and make use of that memory for its future actions — because it does, after all, possess the capacity for doing so.

In this way, as man grows to maturity, the faculty of anticipation and retrospection, and consequently proper reflection and foresight, deliberate thought about oneself, and rational volition, develop ever more fully; he removes himself ever further from the initial state of pure absorption in the current of sensory impressions and instinctive impulses, as every experience made upon himself and others leaves behind it the capacity for conscious recollection and conscious application

to analogous circumstances. Yet we observe that man can at times draw very near again to that state of pure absorption in the current of sensory impressions and impulses, and may for brief intervals sink back entirely into it; we observe further that different men, according to their varying degrees of cultivation, raise themselves above it only to very different heights — a Botocudo comparatively little, a philosopher a very great deal. Keeping this factual relativity in view, we may then readily avoid drawing absolute boundaries in the ordering of different beings in relation to one another — boundaries which nature recognises nowhere — by saying: animals are such beings in whom self-consciousness has sunk to a minimum; plants are such beings in whom, moreover, conscious anticipation and retrospection in time, and all that depends upon them, has sunk to a minimum, or rather has not yet awakened at all, the conditions for its development being absent; leaving open the question of whether the one and the other kinds of being may not also carry some intimations from the higher domain — which I do indeed believe, though it does not immediately matter to insist upon or to pursue the claim. What remains certain is only this: if man can at times suppress his higher faculties to a minimum, let them lie dormant, without his soul thereby ceasing to express itself in lower activities — indeed, if he even begins his existence as a newborn child in precisely this state — then there must also be conceivable beings in whom such a condition is permanent, in whom development does not advance at all, or advances far less proportionately, toward a higher level. This

does not exclude an increasing development within the level of sensory life and impulse itself.

The presumed absence of temporal anticipation and retrospection in plants stands beyond doubt in a teleological relation to their fixed position in space and the correspondingly limited conditions of their existence, upon which I have already touched. The animal must be capable of looking forward in time because it has purposes lying far off in space to pursue, lest its movements miss their mark altogether. Instincts can only be calculated for once-and-for-all determinate conditions of life — what would the infant's instinct to seek the breast avail it, were no breast to offer itself on each occasion — but they are no longer sufficient where conditions change as they do for the grown animal. The plant remains, so to speak, always fastened to the mother's breast; anticipation and the capacity to survey its surroundings could only have been bestowed upon it as a distracting superfluity. But nature reaches no further beyond the requirements of purpose than she falls short of them.

The organic basis of the plant's lack of retrospect and foresight may be connected with the absence of proper circulatory phenomena, which in turn depends upon the absence of a nervous system and vascular system. Nothing within the plant returns upon itself. Everything it absorbs from without serves only as the occasion for it to seek yet more from without, and to seek it in a manner different from before; and this causal relation of the earlier to the later is sufficient to sustain a psychic continuity of whatever psychic content is attached to it — yet of reflected functions in the physical realm,

such as might present themselves as the expression or vehicle of corresponding psychic ones, nothing is to be seen.

With the absence of memory and foresight, much else must naturally be wanting to the plant; above all, everything that can only build itself upon such foundations. To this category belongs the entire domain of representational life proper — not merely the thinking of and about things that exist outside the plant, but also, up to certain limits, the representations of such things themselves.

One may easily be tempted to place the emphasis here upon a false point: namely, upon the fact that the plant, lacking eyes, is unable to receive images of objects in the external world. But through the ear alone, which after all furnishes no images, objective representations of things may nonetheless be attained. The man born blind knows the external world of things just as well as the sighted person, and when freshly operated upon, gains at first no advantage from the image of that world which floods his eyes. Instead of being enriched by objective representations, his existing ones are merely thrown into confusion; he must close his eyes in order to find his way as well as before. The world appears to his eye at first only as a marbled tablet of colours, in which colour means nothing but colour, and line nothing but line — the green patch representing no forest, the red patch no rose. One may say that the images falling upon his eye at first depict nothing to him. Upon what does this depend? Upon the fact that he has not yet learned to carry memories into them. It is not the green that I see in the forest which makes it a forest, or which is more than a small contribution toward it; but that the forest

grows, that it casts shade and gives coolness and warmth, that the bird sings within it and the huntsman walks therein — none of which is contained in the mere sight of a green patch. Only when a composite impression of memories of these and similar things has joined itself to the perception of the green patch, when the sensory image is painted over once more with this spiritual colour, does the sensory impression of the green patch become the objective representation of a forest standing over against me. But a being that has no memories can attach none to the impressions it receives. And thus it is not so much the lack of eyes that is the reason the plant has no objective representations; rather, the otherwise grounded impossibility of having such representations may itself be counted among the reasons why no eyes have been given to it, since the images of objects can acquire meaning and utility only through their interpretation by means of memories. Even if the world were to mirror itself upon some part of the plant just as upon the retina of our eye, and the plant were to perceive the colours and forms of this image just as we do — it would remain as unintelligible to the plant as to the freshly operated blind man; and since the plant would never learn to understand it either, it was naturally more economical to dispense with the image and the camera obscura altogether, to let the sunlight fall directly upon the naked plant, and in so doing to achieve other advantages bound up with the greater simplicity. Every complication does harm where it does no good.

The objection now readily arises that a soul-life so utterly devoid of all objective representation, so wholly surrendered

to the flux of external impressions, cannot be conceived as individual and autonomous at all, but leads us back to the notion of a dissolution into the stream of universal ensoulment. But let us hold fast, rather than to arbitrary presuppositions, to what we may learn from our own experience. I believe we shall proceed more securely thus than if we trust to constructions fashioned a priori in the mind. Pure experiences, to be sure, cannot be made in our own persons, because we ourselves are not such purely sensory beings as the plants presumably are. Yet by observing in ourselves what grows or diminishes or remains unchanged, according as the sensory dimension grows or diminishes, we may well draw a conclusion as to what must occur at that extreme which, though entirely beyond our reach, is nonetheless conceivable.

A palpable example may guide us. Let us imagine several persons — Hegelian philosophers, say — engaged in philosophising, and over against them several others — Hottentots, for instance — absorbed in feasting. The former are to immerse themselves in contemplations upon the beginning and end of the entire world, and thus to cast their gaze as far backward, forward, and about them as is spiritually possible; the latter are to be wholly absorbed in the sensory enjoyment of eating and drinking. Now one may well say that the Hottentots surrender themselves to the external world incomparably more than the philosophers, for eating and drinking is assuredly something far more external than thinking; yet they are not in the least more dissolved therein than the philosophers. On the contrary, each Hottentot retains his sensory enjoyment entirely for himself, just as each Hegelian re-

tains his philosophical thoughts entirely for himself; each feels himself equally to be a being in his own right. The one Hottentot tastes nothing directly of what the other tastes, just as the one Hegelian knows nothing directly of what the other knows. These cases are perfectly equivalent. And even if the Hottentot never said to himself, I taste, there would still be something within him that tastes, and something that no one else tastes along with him. Who doubts that it is the same with animals? The separation of individualities thus does not depend in the least upon the height of their spiritual development.

Let us now carry this to its limit in the case of plants; let us allow them to be as permanently absorbed in sensory life as the most sensory of human beings is perhaps unable to be even temporarily and wholly; yet since no loss of individuality is entailed by the mere process of becoming more sensory, the plants too will be unable to suffer any such loss on that account.

Against this, one may say: what preserves individuality in the Hottentots at their meal is not yet given in their mere sensuality, but is something that reaches beyond it — present not indeed in actu, that is, in actual expression, during the moment of animal enjoyment, but potentia, that is, as a possibility of expression, insofar as it could and would express itself in them under other circumstances. The Hottentots, and even the animals, are after all something more than purely sensory beings, and it is only through this higher element that they detach themselves from the ground of universal ensoulment. Well and good — but in this very sense I maintain

likewise that plants are more than purely sensory beings; potentia, one may seek as much of the higher in them as one wishes; it would require only the addition of inner and outer circumstances — such as must also still be added in the case of the Hottentot before the higher element expresses itself distinctly in him. The sensory may everywhere be grasped as the basis of something higher, which, if not present in actu, is yet present potentia. I mean only that what is already faint and rare in actu among the Hottentots appears in the plants as faintly and rarely as possible. Traces, momentary awakenings, may even be present there; nature cuts nothing off absolutely; and I therefore do not claim that the higher has been cleanly excised from the plant, as one may cleanly cut the blossom from a plant, but only that this blossom has remained in a still unopened bud, rarely or scarcely opening, while the leafy growth of sensory life burgeons vigorously.

Since, however, I set no great store by the reserve of potentia when the task is to depict what is, rather than what might be given the conceivable addition of conditions, I declare the plants to be pretty nearly purely sensory beings. Potentia would ultimately prevent nothing — even a stone might have reason attributed to it on such grounds.

Individuality was in the foregoing characterised by certain distinguishing marks. It is possible that the concept of individuality held by many a philosopher may not accord with this. It is not, however, the concern here to establish or refute any particular definition of individuality, but solely to vindicate for the plant that very thing which is here designated by the term — which is, indeed, the thing around which the real

interest of this question turns. Whoever demands, from the outset, a higher self-conscious spirituality as the condition of individuality will, to be sure, find none in the plant; yet he may still find therein a being that feels for and within itself.

If one asks: what purpose and meaning could it have to place in the world beings who can neither reflect upon themselves nor upon their future or their past, who are helplessly surrendered to the current of sensory impressions and drives — an entirely analogous question would arise in respect to the animals. For although the representations of animals reach forward and backward in time more widely and clearly than those of plants, this still appears so little truly rational and discerning that we, measuring the value of the spiritual solely by the rational and the intelligent, would be compelled to regard animals as equally foolish superfluities in the world as plants. The matter immediately assumes a different significance when one conceives the souls of animals and plants not merely as individuals standing over against one another — which they certainly also are — and the world as a collection of such individuals confronting a God who stands outside them, but rather regards the entire souls of plants and animals as subordinate moments within God's own soul, bound together in His universal unity; for then all the richness and all the diversity of these souls redounds to the benefit of God, while the folly which they possess when conceived merely as isolated individuals standing over against one another, and apart from their connectedness in God, does not thereby touch Him. And what could prove, or compel us to assume, that because we feel ourselves thus splintered and divided

against one another, the same fragmentation exists for God, in whom all the splinters hold together like the fibres of a living tree?

What has been said above is intended, in truth, only to show, against various carping objections, that the independent existence of a level of soul such as we hold the plant's to be is altogether possible, and that it fits within the design of a universal kingdom of souls. That this level of soul is indeed actually that of the plant is rendered probable by the totality of the foregoing discussions. We have found signs of a sensory life of the soul in plants as manifold and, as we believe, as fully valid as, on the other hand, we have encountered no sign that would point to anything higher.

Proceeding to closer particulars, we find, with respect to the most general relations grounded in the very nature of the soul, agreement, but otherwise the most thoroughgoing differences between the soul-life of plants and that of animals — differences which depend principally upon the fact that the plant is wholly dependent upon sensory experience, whereas the animal is so only in part, or to a more subordinate degree. While this places the plant as a whole lower than the animal, it nonetheless places the sensory life of the plant higher than that of the animal; for here it assumes the significance of the full sphere of life, whereas in the animal it constitutes only a subordinate aspect. The sensory life of the animal is the serving, all too often squalid handmaid of a higher authority; the sensory life of the plant is a free country girl, who has her own hearth, cooks for herself, and still finds time to mind her adornment.

Judging by all the signs, the sensory life of the plant shares with that of the animal the twofold aspect of sensations and drives, and the drives are stimulated or released by sensations in a similar manner in the one as in the other. We see the plant, in response to stimuli from nutritive substances, air, light, supports, and the like, putting forth buds, leaves, blossoms, and branches, turning, bending, twining, opening and closing its flowers, and so forth. The entire interplay of sensations and drives presents itself, however, as something far simpler in plants than in animals, with which the far simpler lawfulness of the same is connected. The teleological reason for this lies in the restricted conditions of life of the plant; the organic reason lies in the greater simplicity of its structure. In plants, the stimulus of sensation nowhere has to pass through so many and so varied intermediate links in its effect as in man and animal, where the enormously complex brain is interposed between the action of the stimulus and its discharge in movement. Rather, in plants the aim is only a brief interaction between what is suffered and what is done; not, indeed, so simple that the counter-action is not still in many ways conditioned and modified by the inner organisation; yet on the whole far simpler than in man and in all the more perfect animals. As the light stirs it, so it blooms; as the air stirs it, so it puts forth.

In addition to the drives released by stimuli, we see instincts arising, as in animals, dependent upon particular moods of the general feeling that may be linked to internal organic states and processes.

Just as the soul of men and animals, so long as it is wakeful, is caught up in a continuous flow of vital expressions, we have found occasion to assume the same of plants, with the difference only that this continuous activity here manifests itself in a more sensory domain, and is carried rather by a bodily process directed toward the outer world than toward an inner world. The plant's unceasing act of thrusting forth, of forming itself, of reaching outward, of taking on colour, offers points of attachment for this conception. For once the body of the plant is a carrier of soul, the spontaneous changes and strivings of that body may also be regarded as signs or expressions of corresponding activities of its soul.

The soul of man and animal is, however, subject to sleep, which makes itself known outwardly by the cessation of all spontaneous vital expressions. By analogy with such a cessation, the plant-soul must be subject to a similar sleep in winter. It is only that for the alternation between sleep and waking in the plant, the greater cycle of nature has become the governing, or rather the predominant, principle, whereas for the animal it is the lesser cycle. The alternation between winter and summer is, after all, not without significance for the entire mode of existence of men and animals. In winter, man draws somewhat closer to the dormouse, and equally the alternation between day and night will not be without significance for the plant, only of far less consequence than that between winter and summer. Thus here too the animal world and the plant world complement each other in a remarkable manner. One may attach the following reflection to this. The great period of nature depends upon the revolution of the

earth about the sun; the lesser upon the rotation of the earth upon its own axis. The life of the plant turns more about something external, and in particular about the sun; the life of the animal turns more about itself, and sunlight is of more subordinate significance for its vital processes.

Yet here again no absolute separation. The dormouse, and so many other hibernating animals, demonstrate that the great period can acquire for the animal a significance analogous to that which it holds for the plant, while at the same time confirming the possibility of such a significance in general; and so there may also be plants for which the decline of vital activity during the night can assume the character of a sleep, while that which one ordinarily calls the sleep of plants during the night may well be comparable only to a resting, as the labours of man repose in winter in nature.

In connection with the simpler and more sensory play of the soul in plants, naturally only a simpler and more sensory mutual interplay of souls between them will be possible. Indeed, one may doubt whether such an interplay exists at all. In the meantime, it is rendered probable by earlier discussions that in the fragrance of flowers a means is given for this, which may not, like our language, effect the transmission of thoughts, but perhaps of sensations and instinct-like sympathies, just as in the animal during the analogous period of the reproductive process the sense of smell becomes significant in this regard — although it unquestionably acquires, as indeed does the entire scale of the senses, a very different significance there than in the plant. I intend to say something further on this in the sixteenth section.

One may think also of another means of communication, which combines itself with the foregoing.

Each leaf, as it stirs, agitates the air in a manner particular to its form and attachment, and this agitation, as it propagates to other plants, imparts to them in turn a correspondingly different tremor. This may even be illustrated by a visible analogy. If we stir a stick or a spade through water, we see waves spreading outward, varying according to the nature of the movement and of the body moved; if we substitute air for water, and the moving leaves for the stick and spade, we have essentially the same thing. It is certain that waves analogous to those in water arise also in air, and that each different wave strikes differently upon whatever bodies it encounters.

In us, sound is generated in the voice from within, to communicate inner states to others; in plants it is fragrance that serves this purpose. In us, the ray of light comes from without and passes without our agency from one to another, letting each see how the other appears; with plants it is the wind and the wave of air that play this role.

Such analogies, however, can offer only very remote suggestions.

The inward simplicity of the plant's soul-life, as established through the relations hitherto discussed, is quite compatible with an outward manifoldness in other respects. Indeed, in the variety of external stimuli to which the plant is subject, in the diversity of its several parts, and in the many-sided manner in which it reacts through these parts to those stimuli, there lie sufficient grounds for inferring a manifoldness of sensory impressions and impulses within it. Light,

warmth, moisture, agitation by the air, contact by insects, the influence of nutritive and respiratory substances — all of these act upon the plant in characteristic ways. Roots, leaves, flowers, and within the flowers the petals, the male and female organs of reproduction, are each constructed differently and each behaves differently with respect to these agents, so that none can perform the function of the others. Through its flowers the plant cannot nourish itself; rather, the flowers themselves require nourishment, and conversely the plant cannot accomplish its process of fertilisation, cannot produce seed, by means of its roots. The leaves exhale oxygen in the light and produce green colour; the flowers consume oxygen in the light and produce vivid colours, the organs of fertilisation more so than the petals, the male parts more than the female; the under-surface of the leaves behaves differently in respiration and in relation to light than the upper surface. There are plants whose leaves, when rubbed, smell offensive, while their flowers are pleasantly fragrant, as for example certain species of Datura and Volkameria, and the white lily (Decand. II, p. 770); in taste also the various parts of the same plant frequently differ very considerably, which presupposes chemical processes of differing character. And so it continues through many further particulars.

On account of these differences in structure and function among the parts of one and the same plant, one may conceive not only of a succession but also of a simultaneity of differing sensations in the plant; for in ourselves as well, with the aid of differently constructed parts that accordingly react differ-

ently to stimuli, various things are perceived not merely in succession but indeed simultaneously.

One cannot, to be sure, expect that plants receive from the same stimuli precisely the same sensations as we do — that they derive, for instance, from a fragrance reaching them exactly the same olfactory impression, or from a vibration striking them the same auditory impression, as we ourselves experience. Some certain analogy there may be, but we do not know how far it extends. We already find that animals, according to their structure, are variously affected by the same stimuli, and in general differently from ourselves. What smells and tastes agreeable to one is repugnant to another. For the mode of sensation depends not only upon the nature of the stimulating agent, but also upon the nature of the being stimulated; and why should Nature repeat in one being a kind of sensation that already exists in another, in precisely the same form? Thus the sensations of the plant may differ very greatly from our own, and it may be as impossible for us to form any true conception of their nature as it is impossible for one who has never smelled a rose to picture its peculiar fragrance from that of a carnation or a violet. On the other hand, however, despite all diversity in the constitution of beings, the commonality of the same stimulating agent must also preserve something common to all sensations dependent upon it, so that it may always remain permissible for us, when light acts upon a being, to think primarily of our own sensation of light, and so forth.

That the plant possesses neither similarly constructed artificial sense organs nor nerves such as we have need not, as

was already remarked earlier, give us any grounds for objecting to the claimed occurrence of sensory impressions within it. The following supplementary reflections may support those earlier observations. Even within the animal kingdom, the form and arrangement of the sense organs varies remarkably, always in relation to the mode of life of the animal. Since the plant, instead of needing to move through space and to find its way therein, has only to grow through space and to fashion more upon itself than upon the external world, the artificial arrangement of our higher sense organs could, as has already been noted, be dispensed with, since this arrangement is in truth calculated only to orient us within the external world by means of images or reflections of its conditions. The lower sense organs of smell, taste, and touch are, however, very simply arranged even in us — the last of these affording us at the same time an example of distribution over the entire body surface — and even the higher ones become proportionally simpler as, in descending through the animal kingdom, life in general becomes simplified. From this one must conclude that an artificial construction of the sense organs is nowhere truly essential to the production of sensations, but only to the shaping of these sensations for the service of higher functions of the soul, inasmuch as the higher development of a being's soul-functions is always connected with its more extensive relations to the external world. Thus already in certain insects very simple eyes are found; the organ of hearing, in us a veritable labyrinth, is in certain animals a very simple sac; indeed the polyp follows the light without possessing eyes at all; and it is to be noted that the

polyp is in other respects likewise one of the most plant-like of animals.

As the most essential element of the sense organs, at last only the nerves seem to remain; but our earlier discussions have already shown that they can be regarded as necessary only within the arrangement of the animal, since the plant is capable of performing without nerves whatever else the animal requires nerves for — breathing, the circulation of sap, irritability movements, and the like.

In the animal as well, it is at bottom only the beginning and end-point of the nerves that is essential to sensory perception. The stretch of nerve between its peripheral termination in the sense organ and its central termination in the brain or ganglion acts merely as a conductor and could, without detriment to sensory perception, be conceived of as arbitrarily shortened. Where no brain, no nerve-ganglia are required for the service of higher soul-functions, there will be no need for such conductors leading to them. That which in man and animal is divided into central and peripheral, and thereby permits and indeed organically conditions a development of the whole that surpasses the merely sensory, has no need of this division where the entire life is to remain enclosed within the sensory alone; and therewith the nervous system falls away of itself, since it serves only to restore the connexion between what has been thus separated.

I do not mean by this that conduction through the fibres of the nervous system is a matter of complete indifference. On the contrary, an interaction of what is conducted in the individual nerve fibres may take place in the brain, and this in-

teraction may stand in relation to the higher functions of the soul. But where these higher soul-functions are not at issue, there will be no need either for these reciprocally interacting conductors. It would not, however, be appropriate to attempt here any further elaboration and development of this idea.

If one wishes to have a brief schema — to be understood, of course, only with considerable qualification — one might say: the body of the animal is like a sack whose sensitive surface lies on the inside; particular points of access are therefore required for whatever is to reach the interior from without and stimulate sensation, since everything cannot be an access point; these points of access are represented by the individual sense organs with their nerves. But if the sack were turned inside out, no such particular points of access would be needed; the entire surface would lie freely open to sensation. Plants are, in a certain sense, precisely such inverted sacks, and there are grounds for declaring them to be so. For in other respects as well, the plant behaves, in relation to its uptake from without, like an inverted animal, and has frequently been compared to one as such: the animal takes in air and nourishment through internal surfaces — the alimentary canal and the lungs — and the movements of its limbs serve to thrust these substances inward. The plant takes in all of this through external surfaces; the outwardly directed root fibres of the plant may be compared with the inward-facing intestinal villi of the animal, the outward-turned leaves with the invaginated lungs; the movements of the plant's limbs serve to thrust itself outward into the exterior world. But if this relationship holds with respect to the grossly material, it

is more than probable that it will hold equally with respect to the finer impressions of sense, given that the organs of sensory perception are in part even directly connected with the organs of nutrition.

Although what we have here set forth is only a schema, one may perhaps assign it some significance on the grounds that, even within the animal kingdom itself, great weight is attached to an opposition of position in the organ of sensation: inasmuch as in the higher classes of animals the nervous system is found to be concentrated more upon the upper or dorsal side, and in the lower classes more upon the lower or ventral side. The greater opposition between the animal and plant kingdoms appears to rest upon a merely more decided opposition between inside and outside.

If plants are placed below humanity and the animals by their immersion in pure sensory life alone, they stand, in the degree of development attained within that sensory sphere, in all probability — as has already been intimated — above both.

The following circumstances combine to support this view.

First of all, we find, even within humanity itself, that sensory feeling and sensory impulse, all else being equal, are the more vigorous and developed the more fully a person surrenders to them, the more completely deliberation and reflection and self-examination are stilled. In this respect a certain antagonism plainly prevails. Among peoples undeveloped with respect to higher intellectual life, the senses and instincts are most sharply developed. They understand no music of higher character, and cannot judge a painting; yet they can almost hear the grass grow, rival the eagle in keenness of sight, and

contend with the dog in acuteness of smell. Among ourselves, those of the most sensuous disposition have the least aptitude for higher reflection, and vice versa. Indeed, even in each individual person, this antagonism confirms itself. A man deep in thought neither sees nor hears what passes around him, and a man wholly absorbed in a sensuous pleasure or impulse cannot reflect while so engaged; or if something of that kind does intervene, something is thereby lost from the intensity of the sensuous experience.

If therefore nature has denied the plants the higher functions of the soul, this may fitly be understood as meaning that nature has wished precisely in them to bring the life of the senses to an unfolding and blossoming which would not have been attainable had regard been taken for the higher functions at the same time.

If the savage already rejoices in gaudy colour and in the dance to a rushing rhythm, how much more must the plant be capable of delight in adorning itself with colours in the bright sunshine and swaying to and fro in the rushing measure of the wind. Even for the savage, every ornament and every music still signifies something other than mere colour and tone; the plant knows no meaning to attach to them, it is wholly absorbed in the sensuous pleasure they afford; it only ever loses its satisfaction with what it already possesses and desires ever more of it, and so it makes ever more and ever new green surfaces and dancing leaves; at length it grows satiated even with these and breaks forth into blossom, with an entirely new adornment of colour; now, in place of the wind,

the insect comes — bee and butterfly — and stirs deeper feelings within it.

To be sure, the absence of the higher functions alone could not yet speak for a greater and loftier development of the lower ones; inasmuch as the stone lacks both at once; yet partly the circumstance that plants share with animals the realm of organic life renders it not improbable that the law of antagonism which operates throughout one part of that realm will extend also to the relationship between both parts; partly, all the earlier teleological considerations point toward the same conclusion; and partly, the direct phenomena of plant life itself speak in this sense.

The plant is exposed far more nakedly and defencelessly to the action of every sensory stimulus, and reacts against it with vigorous vital activities, to a far greater degree than we do. One need only recall how much more powerfully light intervenes in the life processes of the plant than in our own; how much more thoroughly it is subject, in all its parts, to agitation; how much more receptive it is to the influences of air and moisture; how much greater a significance fragrance appears to have for the plant than for us; how the plant is even capable of assimilating and mastering the inorganic — a thing we cannot do — and this in the course of a perpetual transformation of its own form. One might object that the lack of such artificial sense organs as the animal possesses, even if it does not deprive the plant of sensory feeling on that account, nonetheless places it in a lower position with respect to such feeling than the animal. But it is not so; inasmuch as the plant, by its entire structure, appears far more as a sense or-

gan than the animal does, and those elaborate contrivances are necessary in animals not in the service of sensory life, but of a higher life. It is a fine thing to find schoolbooks in the hands of children, but only insofar as they also wish or are destined to become more than children. For the pure nature of childhood, this rather does it injury. Such schoolbooks are eyes and ears for men and animals; the plant has no need of them, because it has nothing to learn. Its childlike nature remains all the more beautifully and purely developed for it. Instead of growing from child to adult, the plant in its blossoming passes directly from child to angel, one who exercises its childlike nature only in a higher light.

Which is more beautiful — a map, or a sheet of paper painted purely and simply with colour? In itself, assuredly the latter; and the child takes greater pleasure in it too; but as it learns to understand the map, it passes beyond the pleasure of the painted sheet. Now, our eye paints the world for us as a map, and our understanding teaches us to comprehend it; yet with that, the pure joy in colour is at an end. The plant has no need of a map, since it has no journeying to do; it has received, therefore, instead of one, merely the brightly coloured sheets — but with them it has also received the full joy in them, a joy that endures as long as the colour endures; for when the delight in colour endures no longer, the plant casts away even the coloured sheets themselves. That the plant does indeed perceive something of its own colouring, we shall have no reason to doubt, in view of the deeply penetrating and for each colour distinctive effect which light exerts in producing that colouring (cf. XVI).

The higher significance that sensory life possesses in the plant kingdom, compared with the animal kingdom, is further demonstrated in this: that the animal receives its senses, so to speak, ready-made, as the basis for its higher developments, whereas the very life of the plant appears destined to extend that sensory basis ever further in quantity and ever higher in quality. For the animal, the life of sense is given as something already settled; for the plant, it is set as a task yet to be accomplished. Each new leaf may be regarded as one more organ whereby the plant offers itself to sensory stimuli, and in the flower there opens at last an entirely new and higher realm of sensuousness. With this, sensuousness acquires an immanent purpose which it does not possess in the animal; it acquires an inner life that the animal lacks. In the animal, sensuousness is merely the door; in the plant, it is the very room in which life is lived.

Here too there is no absolute distinction. The animal, after all, does not receive its sensory nature in a finished state; sexual feeling develops only later; and on the other side, as has already been conceded on several occasions, the plant may not be entirely confined to mere sensibility either, and particularly in its flowering the intimation of something higher may transcend that sensibility. Thus the seasons of blossoming touch one another in both kingdoms.

In this significant yet gentle point of contact, people have been content to find nothing but the crudest resemblance. A sexual feeling, they say, awakens in the plant at the time of flowering — and that is all that ever awakens within it. But at bottom this would be a world turned upside down. For if in

the animal the onset of sexual feeling marks the summit of sensory development, it cannot in the plant constitute a beginning of that same development which nothing has preceded. The animal had already seen, heard, smelled, tasted, and felt before sexual maturity. The flowering of sensation was preceded by an undergrowth of sensations, rooted in the processes of nutrition, respiration, and the influence of many kinds of sensory stimuli. How, then, can one acknowledge in the plant that flowering of sensations and yet deny the undergrowth beneath it, while nutrition, respiration, and sensory stimuli play their part within the plant with a force that is beforehand even far mightier than in the animal? One confuses the trace of higher soul-light that unquestionably awakens with the plant's flowering with a trace of soul-light in general. Our dim eye is not entirely closed to the radiance that falls upon the summit of the plant's inner life; but one sees nothing save this uppermost gleam, diminished moreover to a barely perceptible point; the whole beautiful configuration of the plant's inner life remains sunk in night before us.

In my view, the sexual process in the plant is merely elevated higher and more fully set apart into a distinct stage of development than it is in the animal. In the latter, sensory development breaks off at sexual maturity; in the plant, a new garland of more beautiful sensory activities breaks forth; the entire life of sensation ascends to a higher plane that points beyond itself. One might say that the plant already attains here below that third, higher, celestial life which we await only in a hereafter, and of which we hold the bliss of love to be a foretaste. And it is precisely for this reason that the blos-

som offers so many intimations of our future life, a symbol as beautiful as the butterfly, as I have remarked before — though of course it furnishes only a sensory image of it. Thus the plant, in its lowliness, is in a certain sense raised far higher than we ourselves. It receives already in this world a grace that we still await. Even here below, these little ones enter into their kingdom of heaven.

It is at bottom equally thoughtless to acknowledge a soul-life of plants in general, and yet to wish to find it reduced to a state resembling sleep or dream. If we look closely at plants, we shall find everything speaking only against such an assumption. How little does the condition of the plant — which acts and creates continuously from within itself, and stands in the most animated conflict with all sensory stimuli — resemble our sleep, where the reciprocal interactions with the outer world are rather at rest or reduced to a minimum, where nothing new arises but only the old is droned on. Only the condition of the plant in winter can, as has been noted earlier, be compared in some measure with our state of sleep; but since that state admits of such comparison, the state in summer cannot simultaneously do so as well. To say nothing of the fact that, at bottom, nature herself as a whole would appear as a dreamer with half-closed eyes — should one imagine that she lets half her creatures sleep through the long, bright, luminous day, that she bids them open their eyes early and yet sleep on, that she bestows so much vital force upon an oak merely in order to let it sleep for half a millennium? And all the while this oak is fashioning such mighty works

upon and out of itself. Does man do anything of the kind in his sleep?

It will always remain possible, in a certain respect, to defend the expression of a sleep-life or dream-life, in so far as the higher faculties of the soul lie in a kind of sleep or dream. But this is not a proper expression. For in our sleep and dream, not only the higher faculties lie fallow, but the sensory ones as well — perhaps even more completely than the higher. For memories, which form the point of departure of the higher mental faculty, continue to run their course even in the dream, while the senses are entirely closed. But in the plant the senses are entirely open, and memories do not run their course at all. How, in the end, can one speak of a dream where there is no waking from which the dream draws the material of its memories? Waking is conceivable without dream, but dream is not conceivable without waking. To say, therefore, that plants lead a dream-life and nothing more is to say the same as: there exists a shadow and nothing that casts it. It is nonsense; and with this, the plants are supposed to be deprived of their very sense.

We have hitherto followed the life of the plant only as far as the stage of flowering, and have indeed spoken of it as though beyond that stage there were nothing; and in truth the summit of this life, its conclusion on the ascending side, may well lie here, so that it holds less interest to follow it also on the descending side. Yet such a descending side exists, and we cannot regard it as without significance for the plant — whether we think of the great abundance of material and vital force that from this point is still devoted to the de-

velopment of the fruits, or of the great expenditure of purposeful arrangements that come into play here no less than in the process of fertilisation. Whoever already holds the flower to be blind to the light will likewise see in all fruits nothing but hollow shells; but for us, who recognise in the plant's season of flowering only the brightest time of its inner life, the matter must stand otherwise.

When the human being has passed beyond the flowering season of life, he does not thereby become dead; his life merely takes from that point a different direction and significance. Until then more occupied with care for himself and the immediate present, yet never given much to reflection upon himself, receptive to every impulse from without and responding to it vividly, he now begins to contemplate future and past more deeply, to turn more inward, to care for posterity, to labour for those who come after him. The radiance of life fades, significance increases, receptivity to mere sensory pleasure recedes, the organs for it wither gradually; but in return he ripens all the more within.

An analogous turn we shall have to assume, on the basis of analogous outward phenomena, in the plant as well — only that everything which in the human being rises into clear self-consciousness will here fall more into feeling and instinct, which may nonetheless be definite and vital enough. There may begin a kind of inward turning of the plant's feeling upon itself, as its receptivity to external stimuli diminishes — and we do indeed observe the organs for such receptivity actually withering by degrees — while a kind of instinct develops that urges it to reflect or reproduce its own life retro-

spectively and prospectively in the formation of the young seedling within the seed. (One may recall that the seedling is genuinely already prefigured in its whole constitution, with its small radicle and its plumule, within the seed.) One might say that the formation of the young seedling in the seed represents the first and only true thought in its mind — one in which the memory of its entire preceding life gathers itself darkly together and at the same time gives expression to care for the future of another being like itself. Our own thoughts, after all, also attach themselves to bodily processes in the head that leave something altered behind them. Yet as indistinct as the seedling in the seed appears in comparison with the whole plant, so indistinct may be the memory of the earlier life, which now becomes the animating soul of the creation of the new seedling, in comparison with the plant's entire preceding existence. And yet our own memories too are but pale images of reality.

One should not object that the analogous process of the formation of new beings in the human organism is not accompanied by consciousness. It is precisely as with growth. For the plant, this process has an entirely different significance than it does for the human being; what lies at the very bottom in the latter lies at the very top in the former, having passed into the head of the plant. Just as flowering is merely the summit of the growth process in its outward-directed movement, so the formation of fruit and seed is only the return journey in an inward-directed movement, a turning of the growing plant back upon itself. If growth is in general the

bearer of soul-movement in the plant, it will be so equally in the inward as in the outward direction.

The very initiation of the fruit-formation process itself, moreover, reveals the most essential distinction between plant and animal: in the one, it is a process of self-reflection accomplished within one and the same being; in the other, a process divided between two. This may be of the greatest importance for the life of the soul. The plant kingdom and the animal kingdom are not meant to repeat one another in this respect either, but rather to complement one another; what takes place in the animal in the deepest unconscious obscurity, and is recalled only in faint traces by the phenomena of maternal impression to that which ever occurs in the plant kingdom, constitutes in the plant precisely the central point of its conscious life. Extremes meet often enough in other domains as well. Here, this meeting is besides indicated in a manner curious enough in outward appearance.

Indeed, one may regard it as no more than a play of external resemblance, yet it is always singular how the fruit, like the human head, stands in general at the top, is often enclosed by a kind of hard braincase, the seed within it frequently bearing a deceptive resemblance in form to the brain, and how in the higher plant classes there are two seed-lobes, just as in the higher animal classes the brain is divided into two hemispheres; and moreover how the very substance in both cases is of an albuminous nature.

XV. Comparisons, Schemata

XV. Vergleiche, Schemate.

Many have attempted to designate the relationship between animal and plant by means of a single catchword, a simple schema, or an identification with some relation between other objects — to capture it sharply and aptly all at once. For my part, I hold this to be impossible. General expressions, simple schemas, figurative comparisons can at best be useful only for representing a complex relationship after certain aspects, or in a summary fashion. Thus plants and animals may stand in polar opposition to one another in certain respects; yet in how many respects do they nonetheless agree. According to certain relations they may arrange themselves like the steps of a staircase; yet according to other relations the ordering will be reversed. In certain respects the plant may be conceived as an inverted animal; yet one cannot carry this through into all the particulars. One may call the plant a line and the animal a sphere, just as one may call one face more oval and another more round; but has one thereby correctly drawn the true physiognomy of both, or is one able to derive it from this general schema? One may compare plant and animal with this or that concrete thing, just as one may find one head more resembling an apple and another more a pear; yet in how many respects do such comparisons always fall short of what is right, and in how many do they overshoot it? In the end, no designation will remain more apt, more pre-

cise, and more comprehensive for the relationship between animal and plant than to say that it is precisely the relationship between animal and plant. This relationship, in the totality of its moments, is found nowhere else than between animal and plant. Nature nowhere repeats herself entirely.

On the other hand, there is always a certain need to compress complex relationships, to compare kindred domains, and with the application of a cogent method both in the establishing and the use of schemas and comparisons, one might anticipate great benefit for the comprehensive survey as a whole, for the highlighting and connection of essentials, and for the apprehension of affinities between different domains of nature.

Unfortunately, we do not find before us such a method as would truly satisfy the prospect of these advantages; we cannot create one here; and were it created, we could scarcely apply it in a thorough manner, since such application would have to rest upon precise detailed discussions beyond what can find place here, and upon deeper botanical and zoological knowledge than is at our disposal.

Let us therefore attach no excessive weight, indeed not even too serious an intention, to the following attempts at a comparative and schematic apprehension of the relationship between animal and plant. Only here and there may seriousness shine through the play. For this subject has indeed also a playful side, capable of occupying the mind even when it is not with the interest of strict scientific rigour.

Familiar enough, though serving almost exclusively poetic interest, is the comparison of plants — and particularly flow-

ers — now with children, now with women. These seem to be very different comparisons; yet they find a point of connection in the fact that women themselves always remain, after all, only children in relation to men. Moreover, both comparisons grasp the same object from different sides.

The points of resemblance between flowers and children lie in this: that the earth is regarded as their common mother, that they still cling to her and draw their nourishment from her; that all their needs are brought to them; that they do not run off into the wide world; that they appear lovely, gentle, and innocent, doing harm to no one; that they wear bright garments; and that their souls, as we suppose, are still as wholly caught up in the sensory as the soul of a child is. The highest to which they attain with their childlike understanding is to rock and cradle little dolls — little seed-bundles, that is, the seeds that already enfold young plantlets within them — not knowing, yet perhaps dimly sensing, what this truly signifies for those who are grown. Every reader will be reminded by this comparison of Schiller's song:

Children of the rejuvenated sun,
Flowers of the adorned meadow, etc.,

which, to be sure, invites the comment from our side that it was far more the poet than the flowers who were wrapped in night, when he declared them to be so; and that it required no touch of a human finger to pour life and speech and soul and hearts into them, since a far mightier finger had already done so.

One may also recall the opening of a beautiful poem by Heine, which sounds almost unlike Heine, where he says to a

child:

"Thou art like a flower,
So gracious, fair, and pure," etc.

Somewhat less poetic, it must be said, is the effect when Hegel (Philosophy of Nature, p. 471) writes: "The plant, as the first subject existing for itself and still proceeding from immediacy, is nevertheless the weak, childish life, which has not yet opened within itself to differentiation." — Each in his own manner!

Yet still more numerous points of comparison are offered by the character of femininity in plants.

The plant, like woman, remains forever confined within its narrow circle of life, which it quits only when torn away, while the animal, like man, roams freely into the wide world; yet within its narrow sphere of activity it turns everything to the best account, following securely guiding instincts, without ever attaining to the higher intelligence of the animal, and yielding to it, as woman to man, the wider foresight and survey and the transforming interventions in the outer world. The plant remains, like woman to man, always subject to the will of the animal, yet does not itself come to meet it even in the most beautiful of relationships, as is shown by the butterfly to the flower. It likes to gossip fragrantly with its neighbours. It provides for the nourishment of the animal, bakes bread in the ears of grain, prepares vegetables for it. Its dearest occupation, however, until the season of its flowering, is to adorn itself beautifully and to present its form ever anew in loveliness. There are even certain flowers that, like women, rise in white linen and clothe themselves in colour only later

— indeed, change their attire more than once. But after the time of young love has passed, the plant is consecrated to a new vocation. It now casts aside the colourful tinsel finery, and its first and only thought is the care for its little children, which it nurses and carries, and which, once they have at last detached themselves from it, stand about it still for some time longer.

One is here reminded of what Schiller says:

"The man must go forth
Into hostile life,
Must labour and strive
And plant and create,
Must cunningly seize,
Must venture and dare
To capture good fortune....

And within holds sway
The modest housewife,
The mother of children,
And rules with wisdom
In the domestic circle,
And teaches the girls,
And restrains the boys,
And stirs without ceasing
Her diligent hands,
And augments the gain
With an ordering mind.

And fills with treasures the fragrant drawers
And winds round the humming spindle the thread,

And gathers in the cleanly smoothed chest
The shimmering wool, the snow-white linen,
And adds to the good both the gleam and the shimmer,
And rests never."

I do not doubt — since poets always mean something other than what they say outright, which is left to the acumen of the interpreter to determine — that the poet here truly intended to represent nothing other than the relationship between animal and plant; so perfectly does everything fit. The teaching and restraining, the stirring of hands, and certain other details may to some seem less apt; yet it depends, as in all such cases, only upon the right interpretation. Every little plant, while it still hung in its seed upon the mother plant, has after all had to learn from her how it should and should not grow; the endless stirring of diligent hands, however, expresses very aptly the endless stretching out of leaves, the working and creating around itself by which the plant prepares substances in the service of the animal. The treasures in the fragrant drawers are the many precious substances which the plant gathers in cells as in the compartments of a cabinet; by the winding of the thread upon the spindle is meant the spinning of spiral vessels and the other producing of spiral formations with which the plant is perpetually occupied. By the shimmering wool and the snow-white linen, cotton and flax are intended; and by gleam and shimmer, the lustrous colours of the plant.

After this ingenious interpretation, the following simply charming poem by Rückert will perhaps please all the more,

for in it he so beautifully characterises the feminine manner of flowers:

The Flower of Resignation.

"I am the flower in the garden
And must wait in stillness.

When and in what manner
Thou enterst in my sphere.

Comest thou in sunbeam's glory,
Then shall I, heedful for thee,
My bosom still unfold thee,
And fast thy gaze shall hold me.

Comest thou as dew and rain,
Then shall I thy blessing gain
In cups of love to gather,
Let it not cease to flow there.

And dost thou glide along me
Softly o'er me in the wind's way,
Then shall I bow before thee,
Saying: I am thine, adore thee.

I am the flower in the garden
And must in silence wait there,
When and in what manner
Thou enterst in my sphere.

(Rückert, Collected Poems, Vol. I, p. 98.)

As children and country maidens at once, the flowers are characterized in the following lines from Rückert's Amaryllis (Collected Poems, Vol. II, p. 97):

Spring distils from winter's wandering
The dew his children are to drink of;
He tunes the merry pipes to morning singing,
And decks his green house with blossoming garlands.

Come, my heart, let now thine eyes go ranging
For flowers that beckon on each meadow's brink here!
Country maidens they are, right and left they stand there,
Dressed and ready — which one wilt thou choose there?

Plants bear a conspicuous resemblance to insects, partly in respect of individual parts, and partly in respect of the relations of their metamorphosis as a whole — a resemblance that has already given us occasion for many observations in preceding pages.

Even in form and colour there appears a great similarity between flowers and butterflies; so that people have not infrequently compared butterflies directly to loose, living flowers that have taken wing. Indeed, certain orchid blossoms mimic butterflies with remarkable precision; and the name Schmetterlingsblumen, or butterfly-flowers, borne by an entire great class of plants (to which vetches, beans, and the like belong), testifies equally to a prevailing similarity here. The interest of this outward resemblance is greatly heightened, however, by contemplating the living reciprocal relationship between the two, already touched upon several times, wherein the feminine character of the flower is particularly conspicuous. The flower is like a quietly seated butterfly awaiting the visit of its roving counterpart; a relationship analogous to

that which we observe within the insect kingdom itself — for example, between the female and male of the glow-worm. The female, lacking the power of flight, must remain upon the ground; she sits still in the green and attracts the male only by her bright radiance. The male possesses a similar radiance but, one may say, brighter eyes than the female, and seeks her out amid the verdure. Thus the flower's splendour of colour shines forth from its surrounding green; and the butterfly, adorned with equal brilliance of colour but endowed with keener sight, seeks her out — her who, bound to the earth, can only wait to be sought.

As butterfly and flower directly resemble one another, so too do both unfold in a remarkably similar manner from similar structures, within which, at an earlier stage of development, they long lay closed and folded in slumber. Who could fail to find an outward resemblance between the bud from which the flower bursts forth and the chrysalis from which the butterfly emerges — both in order to pass over into the common realm of light? Nay, even the stem, as it slowly grows upward and thrusts forth one leaf after another, may not be wholly incomparable to the caterpillar that, crawling upward, advances one leg after another. Only the plant, as has already been noted, always retains its earlier stages of development visibly beneath itself, whereas the insect absorbs and annuls them within itself.

The air-bearing spiral vessels that permeate the entire structure of the plant, and the — admittedly branched — air-channels that traverse the entire body of the insect, likewise

establish a certain kinship of internal organisation between the two.

Whoever takes pleasure in such analogies may find the relationship between animal and plant reflected within the animal itself in the relationship of the more concentrated nervous system to the more ramified vascular system, or within the plant itself in the relationship of the more centrally enclosed flower to the freely and diversely branching stem. But with what, in the end, could one not find points of comparison? It would be at once tedious and profitless to pursue them everywhere. There was indeed a time when the pursuit of such resemblances was held to constitute almost the entire task of natural philosophy. I shall be the last to wish to conjure that time back again.

The peculiarity of plants, noted earlier, of tending toward spiral formations and arrangements of their parts may give occasion for a variety of interesting reflections. If one is willing to devote a few moments more to a certain symbolic play of ideas, let one consider the stem spirally encircled by leaves, and the spiral vessels extending throughout the entire length of the plant into the flower itself (pistil, stamens, and petals); and let one further consider the nectar contained within the flower, the butterfly that seeks the nectar, and the healing powers that dwell within the plant, residing for the most part in its poisonous and bitter substances. One may then find that the flower compares not inaptly to the bowl borne upon the serpent-entwined staff of Hygiea, into whose cup the serpent — which places its venomous substances at the service of the goddess of healing — darts its tongue from above;

while the butterfly that rests upon the flower may be compared to the soul that seeks therein the nectar of health, yet must, in order to attain it, first pass by the darting head of the venomous serpent; that is to say, it is only through the intermediate agency of healing substances that are in themselves dangerous that the art of medicine leads to health.

Further: let one set the very general spiral tendency of the plant against the tendency, more predominant in the animal, toward forms that return upon themselves and toward circulatory movement. One may then say that the plant, in its processes of formation and internal motion, orients itself more according to the form of the annual (apparent) movement of the sun across the heavens — which is, as is well known, a spiral one — while the animal orients itself more according to the daily movement of the same, which to perception is approximately circular, or, more precisely, represents but a single winding of the sun's annual spiral path; and one may recall in this connection that in sleep and waking, too, the plant follows more the annual and the animal more the daily period. From another point of view one might also say that the plant orients itself more according to the movement traced by a point on the surface of the earth, and the animal according to that traced by the centre of the earth in its movement around the sun; inasmuch as the movement of points on the surface of the earth, being compounded of the rotation of the earth upon its axis and its course around the sun, is likewise a spiral. These, however, remain throughout mere relationships that could acquire significance for science only through

the recognition of some causal connection — a prospect for which no present prospect exists.

The spiral tendency of plants may also be apprehended from a wholly scientific side, and the presentation of a plant-type may in a certain respect be founded upon it. Let us here briefly set out the principal results of Schimper's investigations on this subject.

The schema of all fully developed plants is accordingly representable under the form of an axis standing vertically in the ground, from which radii (leaves) issue laterally according to determinate mathematical laws. The law governing their arrangement upon the axis indicates the essential differences of form among plants, and always appears under the form of a spiral line that winds about the axis and sends out its peripheral radii at determinate intervals. If we call the cycle of the spiral that portion of it which, reckoned from any given radius (leaf), extends until it again arrives at a radius lying in the same line parallel to the axis as the first, the question then is: first, how many radii (leaves) must the spiral traverse about the circumference of the axis in order to pass from the lower bounding radius of the cycle to the upper, and into how many sections is the cycle thereby divided; and second, how many revolutions must the spiral complete within a single cycle in passing through the intermediate radii from the lower bounding radius to the upper. Both the number of sections and the number of revolutions of the spiral within a cycle are constant for each plant species, yet differ among different species, and thus belong to the essential characterisation of the species. Not every number of sections and revolutions is,

however, possible; rather, the numerical values can only be drawn from the following series:

1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233,

whose law is easily discerned. The first two numbers of the series are simply the first natural numbers; the third number equals the sum of the two preceding it, and so in general every subsequent number equals the sum of the two numbers immediately before it. The number of sections in a cycle may therefore be 2, or 3, or 5, or 8, but not 4, or 6, or 7; and the same holds for the number of revolutions. Moreover, the number of sections is linked to the number of revolutions of the spiral within the same cycle by a definite law. If, for example, the number of sections is 2, the number of revolutions is always 1 (expressed as 1/2); if the number of sections is 3, the number of revolutions is likewise 1 (thus 1/3); if the number of sections is 5, the number of revolutions is 2 (thus 2/5); and in general the possible ratios are as follows:

1/2, 1/3, 2/5, 3/8, 5/13, 8/21, 13/34, 21/55, 34/89, 55/144, 89/233

the law of which is again easily found: the numerator of each fraction equals the denominator of the fraction two places before it.

The correctness of the Schimperian theory set forth here is, to be sure, not universally conceded, inasmuch as the constant numerical values of the foregoing fractions are disputed as a general norm by several investigators. The brothers Bravais, moreover, have taken an altogether different path in representing the spiral tendency of leaf arrangement by means of law. Naumann regards the quincunx as the funda-

mental law of leaf arrangement. Mathematically precise positional relations do not in fact exist in the plant at all, and the appearance of so complete a regularity as some accounts would have the plant display emerges only through the correction of observations, the setting aside of exceptional cases, the assumption of failures, and the like. In any case, the approach of leaf arrangement toward a lawfulness that may be referred back to the spiral type is a matter of fact, without the organic freedom thereby being wholly suspended.

A synoptic account of the results of Schimper's investigations, upon which the foregoing is based, may be found in Burmeister's Geschichte der Schöpfung (2nd ed., p. 340). For further detail on this subject see the following writings: Dr. Schimper, Beschreibung des Symphytum Zeyheri etc., in Geiger's Mag. f. Pharmacie, vol. XXIX, p. 1 ff. — Dr. A. Braun, Vergleichende Untersuchung über die Ordnung der Schuppen an den Tannenzapfen etc., Nov. Act. Acad. C. L. N. C. T. XIV, Vol. I, pp. 195–402. — Dr. Schimper, Vorträge über die Möglichkeit eines wissenschaftlichen Verständnisses der Blattstellung etc., communicated by Dr. A. Braun, Flora, year XVIII, nos. 10, 11, 12 (1835). — L. et A. Bravais, Mémoires sur la disposition géométrique des feuilles et des inflorescences, preceded by a summary of the works of MM. Schimper and Braun on the same subject by Ch. Martius and A. Bravais, Paris 1838; German translation by Walpers, Breslau, 1839. — Bravais in Ann. des sc. nat. 1837, Part. bot. 1, 42; 1839, Part. bot. II, 1. — Naumann in Pogg. Ann. 1842 (2nd series), vol. 26, p. 1 (abstract in Wiegm. Arch. 1844, II, p. 49).

After the arrangement of lateral parts upon the axis, the attention of more recent naturalists has been drawn especially to the transformation which those parts so frequently undergo in relation to one another. Let us allow the following brief account by a professional botanist (Link, in Wiegm. Arch. 1842, II, p. 164) to characterize the newer plant morphology directly.

"The task of the newer morphology is to refer the manifold varieties in which the plant presents itself back to a single fundamental form, or rather to derive them from it. It is a procedure in botany analogous to that employed by the crystallographer in mineralogy, who derives from more or less precisely determined fundamental forms the various secondary forms that occur in nature. Plants, however, possess in place of crystal faces actual members, of which the axial parts first consist, and upon which the lateral parts are situated as members in their own right. The means employed to produce such derivation are as follows: one allows the parts to enlarge, diminish, and wholly disappear (avorter) in thought; further, to contract and expand, to move apart and draw together, to fuse and separate, to become more delicate and more coarse, and so forth, as observation has found them to behave in nature. It has been found in particular that the lateral parts transform into one another, and that the leaves may be regarded as the fundamental form from which all other lateral parts, down to the coverings of the embryo, are derived. This is the metamorphosis of plants, which in France is now called, in accordance with a new fashion, the Goethean metamorphosis, as it has sometimes also been named in

Germany. It ought properly to be called the Linnean, since Linnaeus had already set it forth in its entirety."

It will readily be perceived that the method described above for producing derivations is by its very nature such as to permit everything to be made from everything. And in this respect no small degree of arbitrariness has indeed been exercised. Nevertheless, the transformation of lateral parts into one another remains a most remarkable and significant phenomenon, concerning which the reader may consult Goethe's essay on plant metamorphosis for fuller particulars.

The most general and important significance for the relation between animal and plant seems to me to belong to the contrast, already touched upon several times, between their respective directions of development — inward and outward.

In brief, one may say: the animal grows more into itself, the plant more out of itself; the former articulates and folds itself more inwardly, the latter more outwardly. This difference is, to be sure, not absolute, but such that one may observe how, in the course of development from the ambiguous intermediate kingdom onward, the preponderance in the animal kingdom has on the whole fallen more to the first side, and in the plant kingdom more to the second.

Indeed, let us set animal and plant in opposition at their more perfect stages.

The animal is outwardly more compact and self-enclosed, in a fairly firmly determined form, with few external appendages fixed once and for all, and with equally determinate blunt impressions upon the uniform mass of the body; while inwardly it articulates itself into a manifold of organs that in-

creases ever more from the lower to the higher animals, which organs further divide themselves into ever finer and finer subdivisions, and whose innermost and last modifications ultimately follow the freedom of the movements of the soul itself — inasmuch as, in connection with the development of the intellectual and emotional faculties in the course of conscious psychic life, the innermost organizational relations continue to form themselves to the finest degree. In the brain, the ultimate fibres shoot through one another like warp and weft of a fabric; for when growth and division have proceeded ever inward and downward, nothing remains at last but to grow through oneself, or to divide what has already been divided in yet new directions. To the activity and progressive formation of these inner crossings is then attached the higher life of the soul.

The plant, on the other hand, presents internally, even at the summit of its life, ever and again only its uniform mixture of fibres, cells, and tubes, without clear articulation into inner organs; while it grows outward into an inexhaustible profusion of externally diverging formal parts — a profusion that increases from the lower to the higher plants, from the trunk to the branches, from these to the twigs, from these to the leaves, from these to the leaf-veins — whose last outward shoots are presumably connected with the freedom of its inner vital impulses. This too proceeds toward a final interweaving, though in a different sense than before: for the branches, and then the leaves, grow through and among one another, thus forming the leafy crown; while the leaves them-

selves arise by virtue of the leaf-veins, branching ever more finely, finally meeting and flowing into one another.

This conception gains an increased interest when we set it in relation to that schematic one, according to which the body of the animal behaves like a sack whose sensitive

The surface is interior in the animal's case, while in the plant it lies exterior, the entire relationship being reducible to the opposition of invagination and evagination of this sac. Indeed, the inner and outer branchings of the animal and plant organisation may well be conceived as invaginations and evaginations that proceed ever further inward and outward in continuous succession. One may observe, moreover, that nature in general takes pleasure in opposing to invaginated forms their evaginated counterparts, of partly parallel, partly complementary significance; as for example lungs and gills, or the genitalia masculina and feminina. Here, then, we have this opposition carried through in its grand entirety between two kingdoms. The folding hand has in each case made its attack upon the insensate surface of the sac, and thus the sentient surface of the animal lies buried within its inner invaginations, while that of the plant is laid bare upon its outer evaginations. (It must, of course, be admitted that even the opposition of sentient and insentient parts of the organism is to be taken only cum grano salis.)

The closed sac of the animal folds inward upon itself in the first instance, so that a doubling arises, as with a nightcap sitting upon the head; in the plant's sac, by contrast, the inner doubling is drawn far outward. The invagination in the animal forms the intestinal canal; the evagination in the plant

forms the root. The infolding movement in the animal proceeds with such force that the cap bursts open above, giving rise to the mouth, while below it contracts into the anus. The animal's intestinal canal is then further invaginated into the salivary glands, the liver, the pancreas; lateral invaginations of the sac are the lungs and the genitalia feminina. The sac of the animal, however, is composed properly of a double membrane, and the inner membrane does not follow the outer. Rather, it has detached itself from the outer, has been torn open, and has been compressed into the smallest possible space, into the inwardly folded brain and spinal cord; while the outer membrane, as skin, has swelled out as broadly as possible around its invagination, the intestinal canal. Thus a great cavity arises between the skin and the intestinal canal, within which the neural membrane lies folded, and which it is therefore far from filling. In order not to leave too great a void, the skin is thoroughly lined with a cushion of flesh and connective tissue, and in order to lend the whole its support, it is held taut by firm struts, that is to say bones; the wadding is also well stitched through with networks of vessels, and by this means the neural membrane is simultaneously sewn to the cutaneous and intestinal membranes. Furthermore, at the moment of the neural membrane's detachment from the cutaneous and intestinal membranes, the nerves remained behind as connecting fibres with the cutaneous membrane, and the ganglia as frayed tufts upon the intestinal membrane.

In the plant, no such separation of the sac into two distinguishable membranes is visible whatsoever, and the evaginated plant-integument is simply stuffed with fibres and connec-

tive tissue. The vegetative and the sentient membrane here fall into one. And this is a distinction which adds itself meaningfully to the distinction in the direction of invagination and evagination, and stands beyond doubt in a causal as well as a teleological relation thereto.

At bottom, of course, it is not a real hand but the schematising imagination that performs all the folding movements indicated above. Strictly speaking, no membrane folds itself either inward or outward at all; rather, cells form themselves gradually in such positions, grow and are reabsorbed in such ways, that the appearance of something unfolded transforms itself by degrees into the appearance of something folded inward or outward. The result is ultimately the same, but the process is a different one from that by which we ourselves actually accomplish foldings and invaginations and evaginations in reality.

I confess that the conception of the manner in which the neural membrane comports itself is somewhat novelistic, inasmuch as it is drawn more from a bold retrospective interpretation of the completed conditions of arrangement than from a careful examination of the actual conditions of development; which must hinder one from attributing to it any great scientific interest. The general opposition of evagination and invagination between plant and animal, on the other hand, seems to me very decidedly established.

The continuous evagination advances in the plant only until the apex of its life is reached. There comes a moment, the moment at which the stamen or its pollen touches the stigma of the pistil, when the plant strikes back, so to speak, against

itself, and with the penetration of the pollen tube into the cavity of the ovary there now begins a process of invagination previously only suggested, which continues throughout the entire formation of the fruit.

The second oscillation of life in the plant thus proceeds in a direction entirely opposed to the first. In the animal this is not so clearly the case, since from the very outset the life-process here takes a direction more inward; yet relatively, an equivalent reveals itself even in the animal in the fact that until the age of maturity the animal still grows outwardly in size, while afterwards it develops further in a merely inward sense. One must not, however, seek to extend the validity of the schema beyond its legitimate bounds. In the domain of the lowest organisms, which approach the intermediate kingdom, evaginations occur frequently in animals; but the opposition becomes the more distinct the higher we ascend in both kingdoms. Even in the higher animals the limbs, the nose, the genitalia masculina, the mammae, and the hairs are evaginations, contrary to the otherwise prevailing character of the animal kingdom.

Let us cast a glance at the significance which the foregoing opposition must hold for the life of the soul.

Insofar as the soul is something determinate, and according to its determinacy finds and demands a determinate expression in its bodily bearer, one will not be entitled to suppose that the particular determinacy of the soul as expressed in the animal body stands opposed to nothing; rather, there will stand over against it a determinacy of soul of an opposite kind. The plant soul will be something developed only in an-

other, and in certain respects opposite, direction; something unfolded toward the outer world, while the animal soul is something folded inward upon itself. That the inward-turning movement leads the soul, so to speak, more to itself, allows it to come back upon itself, is expressed in the schema by the fact that the sentient surface, by virtue of its infolding, turns back against itself, whereby inner contacts arise between its parts, and ultimately crossings and intersections, so that what is sensuously stimulated therein may enter into new relations of efficacy. In plants, where the sentient surface evaginates outward, this is not the case; for even though branches and leaves, in their all-sided divergence, do ultimately interweave with one another, they nevertheless remain for the most part without contact, and where they do make contact in individual leaves and throughout the leaf veins, everything merely lies against everything else, or anastomoses, without crossing and re-crossing from the point of contact onward, as we see it in the brain of animals. Thus animal life retains over the plant a dimension of inwardness; and for this very reason the plant remains more at the level of simple sensation, until with the descending direction of life the direction of infolding also gains a more determinate foothold in the plant, and now indisputably acquires a higher significance for it. Yet it does not govern the entire life of the plant from the very outset, as it does that of the animal; it is, so to speak, only the bending tip in which the plant terminates and to some degree turns toward the animal. The plant bears, so to speak, a small animal only as the crown, the ornament, and the topmost summit upon the pyramid of its structure and life, and even then a

Sphinx, which represents the essence of the animal only in riddle, while the animal is from the very base what it is, like the column of Memnon standing beside the pyramid.

A similarly fundamental opposition to that which exists within the organic realm between the formation of animal and plant may be found also in the wider domain of nature, between organic and inorganic formation itself, with the difference only that it there reaches back to the elementary structure, whereas in the former case it pertains to the plan of the whole.

Organic creatures, whether animals or plants, arise from elementary parts that grow inward, folding and dividing themselves toward the interior; inorganic beings, the crystals, arise from parts that grow outward, unfolding and consolidating themselves toward the exterior. The elementary parts of organic beings are to be regarded as cells — hollow vesicles filled with fluid, whose walls thicken from without inward, so that the lumen of many vanishes entirely with time. Projections arise, it seems, through inward folding, and finally partition walls, by which the cells divide into several. The crystal, by contrast, arises from a solid primary crystal within a lye, thickens through accretion from without, and folds itself outward, so to speak, into corners, points, and edges, without thereby relinquishing its solidity; for instead of continually generating new cells within itself and fragmenting into them, becoming ever more vesicular, it rather encases itself in ever new crystalline shells closing around the earlier ones, and thus becomes an ever larger, compact whole.

It is remarkable how such simple contrasts in the plan of formation as we observe between animal and plant, organism and crystal, can yet issue in results that reach so far beyond the character of simple opposites, carrying with them wholly different degrees of unfolding and involution. Let one compare the enormously complex organisms with the ever so simple crystals, and within the organic realm the comparatively complex animals with the comparatively simple plants. The direction of development inward evidently possesses a wholly different, more pregnant character, and one at the same time more significant for the life of the soul, than development directed outward.

A scheme, admittedly very superficial, having regard only to the most general and outward morphological relations, yet not wholly without interest and capable of deepening in many directions, presents itself as follows.

The roundly self-contained, generally elongated form of the animal body resembles, when viewed in comparison with the plant, the ellipse on the whole more closely — with heart and brain perhaps serving as the foci around which all the animal's life revolves — whereas the form of the plant, by virtue of its twofold and opposed divergence upward into branches, leaves, and blossoms, and downward into the radiating roots, resembles the hyperbola more nearly. And if we posit the simplest case of a stem unbranched above, bearing but a single flower, then the flower, as the very apex of life, will represent the upper half of the hyperbola, and the endpoints of the plant's axis — the stigma of the style and the tip of the taproot — will occupy the positions of the foci, between which

all the life of the plant oscillates; the two nodal points from which the flower stretches upward and the root downward will be the vertices of both halves of the hyperbola; and the leaves, reduced to their mean horizontal direction, will indicate the direction of the secondary axis passing into empty space.

The intermediate realm between animal and plant, wavering between spherical forms and linear forms, is then represented by those cases where ellipse and hyperbola pass over, through the greatest possible simplification of their equations (without anything becoming infinite), into spherical and linear forms, which may come about in several ways — and with this the protean nature of the intermediate realm is connected.

It is well known that the hyperbola arises from the ellipse by imagining one principal magnitude taken in reverse direction within it; which accords with the fact that the plant may in a certain sense be understood as an inverted animal. One may also relate the descending phase of plant life, where the flower is seen to transform itself into the more ellipsoidal fruit, to such a reversal.

This scheme gains in interest when one allows it to pass over into the symbolic. The series of possible ellipses has as its limit the parabola, which, while on one side still wholly subject to finitude, opens itself on the other toward infinity. For the ellipse, as is well known, passes into a parabola when one of the foci of the ellipse is displaced to infinity, or, what amounts to the same thing, when its major axis is taken as infinite. Inasmuch as the realm of the various ellipses repre-

sents the realm of animals still entirely bound within finitude, the parabola, as the upper limit of the ellipses, signifies the upper limit of the animal kingdom — man, who on one side is still rooted in the earthly just as the animal is, while on the other he opens himself toward the heavenly. His brain, to be sure, that one focus, does not truly lie in infinity, but it is capable of conceiving infinity and subjectively encompasses it. It is precisely by this that the scheme passes over into the symbolic.

The parabola might, rather than being regarded as the limit of the ellipses, also be regarded as the limit of the hyperbolas — but in a different sense. In the transition of the ellipse to the parabola, a wholly finite being becomes one that is infinite on one side, the animal passes over into something half animal, half angel; in the transition of the hyperbola to the parabola, conversely, a being infinite on two sides, through the loss of one infinite half, becomes a being infinite on one side only. Accordingly, man may equally well be regarded as an animal raising itself from earth toward heaven, as a plant transplanted from heaven into the earthly — yet with the loss of one heavenly half.

The comparison of animal and plant with ellipse and hyperbola may acquire a more scientific interest than the foregoing account allows it, through the following relation to the principles of a general mathematical morphology, upon which I shall here content myself with a few indications.

The general formal difference between organic beings (animals and plants) and inorganic beings (crystals) consists, briefly stated, in the fact that the former are bounded by

curved surfaces, the latter by plane surfaces. The curved forms of organisms run through all degrees from the spherical form (approximately so in certain seeds, fruits, eggs, and lower animals) to the most complicated forms, which are no longer susceptible of precise mathematical calculation or representation in formulae — though this is, at bottom, true of all natural forms whatsoever, for even crystal surfaces are, strictly speaking, only approximately plane. One abstracts from minor irregularities; such small matters are overlooked. But even for the contemplation of the most complex natural forms, one may attain an exact mathematical standpoint by asking which among given simpler forms they most resemble — a question that always admits of precise determination by measurement and calculation; asking, for example, to which sphere a given human head is most similar, or, if one wishes to go further, to which ellipsoid, or, if one would venture still higher, to which solid bounded by surfaces of the third or fourth order. One may also subject any particular parts and surfaces thereof to such examination. Now, after plane surfaces, or surfaces of the first order, surfaces of the second order — that is, those which yield conic sections as cross-sections or projections — are the simplest. And so, were one to ask what kind of conic section the form of plants, and what kind of conic section the form of animals (for a cross-section through the major axis or a projection onto a plane parallel to it), most resembles, one would find with complete exactitude the hyperbola for the former and the ellipse for the latter; indeed, for each particular plant and each particular animal, mathematically speaking, the particular hyperbola and the

particular ellipse could be specified to which they are respectively most similar.

Admittedly, from such a determination — remaining as it does so remote from the true form and not without its laboriousness — one could scarcely expect a result of practical use to science. Yet the standpoint of mathematical morphology here proposed seems to me to promise useful, and at all events interesting, results for classification and perhaps for still other general relations, if applied to the intrinsically simpler forms of animals and plants, or to those parts where the approximation no longer departs very greatly from reality; and this has already been undertaken at least with regard to the shells of snails, notably by Naumann, with success. But the subject unquestionably deserves a more extended treatment. Seed forms, fruit forms, and the forms of eggs in particular would seem worthy of attention, partly on account of their simplicity, and partly because they already contain the whole plant or the whole animal in nuce.

XVI. Colours and Fragrances

XVI. Farben und Düfte.

The colours and fragrances of plants are something so beautiful and enchanting for us, and so full of significance for the plant itself, that after all we have said of them in passing, they well deserve a few words of particular consideration.

Let us imagine the plants removed from the earth — what would remain to be seen but yellow desert sands, grey rocky crags, bleak fields of snow and ice? As bare as a tree looks in winter, so bare would the whole earth appear. It is the plants that weave for it that beautiful green garment, whose cheerfulness refreshes and delights the eye, and by which the eye itself may be restored to health. We too make our clothing mostly from plant materials, dye it with plant colours, as the earth does; but our garment is a dead one. The earth has clothed itself in a garment of self-living substances with living colours — a garment whose meshes weave themselves, colour themselves, renew themselves, an eternally fresh, never-ageing vestment, from whose remnants our own clothing is first made. It is singular enough, to be sure, that the inanimate should put on a living garment, while we who are alive put on a dead one. But is this not perhaps a singularity that exists only in our notions, not in nature itself? Is the earth truly as dead as we take it to be?

We may certainly believe that, wherever pleasure and intention exist at all, this adornment of colour bestowed upon

the earth will not have been made without pleasure and intention. Only, we must then know how to attach pleasure and intention not merely to a governance of God over nature, but also within nature itself.

The production of colour does not, in any case, depend upon the plant alone; the plant contributes its own particular vital conditions, but beyond and above it lie greater, more general conditions, extending over the whole plant world. And so one may, pointing to these general grounds, say: it is the sun that passes over the sky, that shines upon all herbs, whose radiant brush colours the earth green and many-hued; indeed, the sun itself appears only as the fist of God, guiding this radiant brush, sweeping it daily back and forth across the surface to be painted — at first, in spring, with light, gentle strokes, then with ever bolder, more vigorous ones. It is in fact known that all the greening of plants and all the colouring of flowers takes place only through the stimulus and under the influence of sunlight, which itself contributes nothing of material substance toward them — no more than a brush contributes paint. But whence, then, is this colour drawn? From the colour-shell of the sky; for we know that the air, whose luminous appearance forms the vault of heaven, supplies the substances from which plant colours are developed — not the earth. The earth provides only the coarse substrate, the canvas, as it were.

It is chiefly the carbonic acid and the oxygen of the air that participate in the production of plant colours, while from the earth it is predominantly mineral constituents that pass into the plant.

The action of sunlight in colouring plants becomes all the more similar to the action of a brush in that it operates entirely locally. For a part of the plant kept from the light remains white, while the rest of the plant turns green.

One may ask why green should be the principal colour of the earth — why not blue, not red, not yellow, not white? Well, blue already belongs to the sky, and golden already to the sun, and red already to the blood, and white already to the snow; and so one might, playing with another image, say: the golden sun and the blue sky join together for no other purpose than to beget green plant-colour as their child; while the red in blood and the green in sap are destined to complement one another, as the animal kingdom and the plant kingdom are in general ordained to complement one another in so many other respects — for it is known that red and green stand to one another in the relation of optical complementaries, that is, they may be mixed together to produce white. Just as organic life on earth has divided itself into two realms, so too has the heavenly gift divided itself by which it grows and flourishes; and to the gentler part has fallen the gentler colour, to the more active the more active.

This does not, of course, answer the original question, but rather extends it into the following: why precisely this distribution within the whole system of the colours of nature?

And I reply further: the earth will be green for no other reason than why the kingfisher is blue, the canary yellow, the flamingo red. Among the other heavenly bodies, there was to be one that should be, in its prevailing character, green; this fate fell to the earth — why to this one in particular cannot,

naturally, be further specified. Other heavenly bodies will accordingly bear a different colour. Indeed, it has actually been conjectured that the reddish hue of Mars is owing to a red vegetation upon it.

The circle of the question is again enlarged, the explanation pushed further back — yet every such recession of explanation is itself already a step toward explanation. Into the infinite, however, we cannot proceed.

Can the green colour of the earth truly be altogether accidental? But why, then, should the green of the sea begin precisely where the green of the plant world leaves off? In the beginning, indeed, all was covered with the uniformly green, azure-tinted colour of the ocean. But when the land rose and wished again to have colour, the Creator covered it with the body-colour of the plant world and chose green once more; and even from the heights of the land the glacier-waters flow down again in green. Sea as well as land green, the beginning as well as the end of the waters green. This seems truly to indicate that a wholly green skin of the earth's body was indeed intended, just as a wholly blue mantle was intended for it. In the grand scale, nature desires colours that remain constant; variety she reserves for the small. The clouds of the sky are not blue, any more than the animals of the earth are green; but both alike pass only singly through the air or across the land.

If we turn to a consideration of the individual relations of colour to the plant world and to the single plant, it remains ever remarkable that green belongs as predominantly to the herbage as it is absent from the blossom, though not without

exceptions on either side. In this connection, those species that flower in green usually possess no pure green, but only a dirty yellowish-green or greyish-green; and many apparently green-flowering plants, such as the grasses, frequently have not so much green-coloured as colourless floral glumes. Pure green is in truth very rarely found in flowers (Schübler).

Among leaves there are many that are red or variegated; many are yellowish when young, and most turn red or yellow in withering.

There are even entire plants that become green in none of their parts, and these belong, remarkably enough, all to the parasitic plants — that is, plants that take root upon other plants; such as the broomrapes, the species of Lathraea, the Cytineae, the species of Cassytha and Cuscuta, the Monotropes, and the leafless orchids (De Candolle).

This contrast between the green herb and the differently-coloured flower is connected with a contrast in the vital expressions of the two. Flowers that are not green consume oxygen and exhale carbonic acid under the same conditions in which green leaves absorb carbonic acid and breathe out oxygen gas.

Equally, nature has shown itself wilful in the fact that pure black does not occur in flowers; even the darkest spots on flowers that one might at first glance take for black reveal, upon closer examination, a peculiar and distinct play of colour.

De Candolle says on this subject, in his Physiology, Vol. II, p. 726: "Black would appear not to be a colour natural to flowers; rather, those flowers in which black is found are as a

rule originally yellow flowers passing into a very dark brown. This last seems at least to be the case with the blackish parts of the flowers of Pelargonium tricolor Curtis and Vicia Faba L. (the broad bean). The same holds for those brown or black flowers whose colour is a very dark red, as we see, for example, in Orchis nigra All."

The translator Röper adds in a note:

"The apparently black spots in the corolla of Vicia Faba L. are in truth only a very dark brown, as may clearly be perceived with the aid of a microscope. The apparently black hairs on the floral-envelope scales of Protea Lepidocarpon R. Brown appear, under strong magnification and by transmitted light, as dark violet shading into indigo blue. They are in part intermingled with yellow hairs and are surrounded by yellow hairs."

It is maintained that pure white occurs among flowers no more than pure black; inasmuch as even the whitest flowers, when observed against coloured paper, still betray a tinge of colouration by contrast (cf. Decandolle, Physiol. II, p. 723); yet I suspect that the intrusion of subjective complementary colouration — which is more vivid for some eyes than others — gives rise to illusion in this matter. From the few white flowers available to me at the present season, I could obtain no confirmation of that assertion.

If white light has already divided itself between the animal and plant kingdoms in such a manner that red fell to the animal body and green to the plant body, it is remarkable to observe how green now undergoes a further division within the plant kingdom itself, the opposition of yellow and blue — still

united in the herb — separating in the blossom. Much as among human beings there prevails a contrast between fair and dark colouring of hair, skin, and eye, whereby they are to some degree sorted into two classes, an analogous contrast between yellow and blue flower colours recurs among blossoms. The facts are as follows:

Schübler and Frank have demonstrated, in a particular treatise, that flowers may be divided into two great series: those which have yellow as the basis of their colour (the oxidised, or xanthic series), and those in which blue forms the basis (the deoxidised, or cyanic series). Flowers belonging to the first series may, depending on variety or species, vary only through yellow, red, and white, but not into blue; flowers belonging to the second series, on the other hand, vary only through blue, red, and white, but not into yellow — so that the two series meet in red and white, but diverge in blue and yellow.

Thus there are no blue cacti, aloes, roses, buttercups, tulips, mesembryanthemums, dahlias, and so forth, but only yellow, red, and white ones; these belong to the first, the xanthic series. Conversely, there are no yellow bellflowers (campanulas), geraniums, phlox, anagallis, asters, and so forth, but only blue, red, and white ones; these belong to the cyanic series. Some exceptions to this rule do occur — as, for instance, certain yellow varieties among the hyacinths, which on the whole belong to the cyanic series — yet such exceptions are rare.

The genera of plants belonging to the xanthic series are far more frequently inclined to the formation of acidic substances

than are those belonging to the cyanic series; the latter, by contrast, are not seldom distinguished by peculiar sharp, bitter, and narcotic substances that often act powerfully upon the body. Nevertheless, one must not regard this as a rule admitting of no exceptions.

At the awakening of the year, comparatively the greatest number of flowers are white; at its close, yellow. It is as though, in the one case, the snow of winter, and in the other the sun of summer, exerted a lingering after-effect.

Detailed investigations into the relative distribution of flower colours (within the German flora) across the various months of the year have been published by Fritsch in his treatise on the periodic phenomena of the plant kingdom, in the Transactions of the Bohemian Society of Sciences, 1847, p. 74.

Turning now to the relationship between plant colouration and the phenomena of the soul — a matter which more nearly concerns us here — the plant, for want of eyes, can of course perceive neither the beauty of its own colour nor that of its neighbours in the same manner as we do. For although it is susceptible to the stimulus of light, the coloured light arriving from different points in space mingles indifferently at every point on its surface and is thereby effaced into a general luminous impression. But are we therefore to regard the flower's own beauty as lost to it? Certainly not; it gains such beauty from another quarter, and gains assuredly more thereby than we ourselves can ever draw from it — as truly as that which one creates oneself appears, in the moment of creation, more beautiful and significant than it does to another to

whom it is then offered; however similar it may otherwise appear to both. In truth, the production of colour is most intimately bound up with the active life-process of the plant, which is indeed stimulated by external light, yet gives forth colour only through its own reaction against that stimulus. We cannot, to be sure, swear that the plant, in the process of generating its green and red and blue, perceives those colours in the same sensation of colour as we do in external intuition; we have rather reason to doubt it; yet nothing, on the other hand, prevents us from thinking of something analogous. Should the human being, who is meant to mirror within himself all the principal moments of what occurs upon the earth, not also mirror within himself this principal aspect of the plant's inner life? In any case, the plant certainly has, in generating the various colours, sensations as various as those we experience when beholding them; for the generation of each colour is connected with distinct internal changes within the plant.

In a certain sense, the production of plant colours may be compared to production by our own imagination. The plant, one might say, transforms light into colours in a manner akin to fantasy. Light falls upon the plant — white, or variously coloured; the plant perceives its action in some fashion; yet it does not render it back as it received it. Rather, the light has served only to arouse within the plant a self-creative activity by which colour is generated — and this activity is, beyond question, accompanied by the feeling of self-creation. So too our imagination requires the sensory stimulations of the outer world, yet requires them only to be roused thereby into in-

ner acts of self-creation, which bring forth from within what was received, in transformed form and with the feeling of autonomous action.

Even the white flower, although it appears merely to reflect back the light in altered form, does not conduct itself passively towards the light; for the whiteness of flowers likewise rests upon active processes, by virtue of which the flower renders light back in heightened fullness and purity — just as the human imagination is capable of giving birth, in a work of art, to the relations by which it was stirred, in purer and more beautiful form, and of thereby raising them for the first time to the full vividness of contemplation. The flower makes of itself alone the work of art. Where could we observe the whiteness of light more fully and beautifully than in the whiteness of lilies and other white flowers?

Animals and human beings, it is true, also colour themselves at the surface, without our being prompted to ascribe to this process of colouration a significance similar to that which we assign to it in plants. Yet between the manner in which the colouration of plants comes about and that of animals, there obtain distinctions analogous to those between the growth of both (cf. VIII.), and one is therefore no more entitled to attach an entirely different significance to the former — a matter into which I shall not enter again in particular detail here.

For further particulars on plant colours from a physiological and chemical perspective, see, in addition to the textbooks of plant physiology, Fechner's Repertorium der organischen Chemie, II, p. 832; abstracts from the more recent treatises

by Mohl, Pieper, Marquart, Hope, Berzelius, Decaisne, Elsner, Turpin, Morren, and Hünefeld in Wiegmann's Archiv, 1835, II, 186; 1836, II, 85; 1837, II, 35; 1838, II, 32; 1839, II, 80; 1840, II, 91.

Now a few words concerning fragrances:

The fragrances of flowers appear to play only a subordinate role in comparison with their colours, since not even all flowers are endowed with them. And if it is true, as we intimated earlier, that the fragrance of flowers has as its principal purpose the effecting of a communication of sensations or instinct-like sympathies between different plants, then this is readily explained. The generation of colour in plants is connected with the development of their own inner processes of soul; these, however, are naturally more important and more necessary than the interplay with other souls.

Among animals likewise there are those that live in society and those that live in solitude. The fragrant plants represent for us the former; the scentless plants, the latter. And the plant may, given the nature of its limited sphere of life and the circumstance that the sexes are already united in each individual, stand in need of psychic intercourse with its kind even less, on the whole, than the animal.

The animal itself teaches us that scent is truly capable of serving the sensory and psychic intercourse between beings, and notably so for the analogous period of the reproductive process. This is always important for interpretation. Yet among animals this intercourse proceeds, on the whole, incomparably more through the voice. And in this respect, as in so many others, one may say: fragrance assumes among

plants a significance similar to that which the voice holds among animals. There are several points of correspondence.

From the interior the voice comes, from the interior the fragrance comes, and both are at once the finest and most certain distinguishing mark of that from which they proceed. Just as one may recognise every person in the dark by the tone of the voice, so in the dark one recognises every flower, indeed every variety of flower, by its fragrance. Both characteristics, seemingly simple in themselves, vary in the most diverse nuances and thereby denote an equal number of nuances of organisational complexity, of which they are the highest and most fully developed product. Each bears, as it were, the soul of the being from which it arises, away upon its wings.

It would unquestionably suffice merely to cultivate the olfactory organ with sufficient delicacy, in order to distinguish not only every variety but every individual hyacinth or carnation from every other by scent alone. Our olfactory organ is in this respect partly unpractised, and partly not so naturally disposed toward such discrimination as the flower's own may be, since such distinctions are not of the same immediate concern to us. After all, the Negro also distinguishes physiognomically the faces of his countrymen with great ease, faces which all appear to us much the same.

The lower animals, which have little to communicate to one another — worms, insects — are on the whole mute; and so too the lower plants, fungi and lichens, are without fragrance. It is true that certain insects exceptionally produce sounds, but only through outward rasping, buzzing, and bor-

ing; the tones do not issue from within. Similarly, certain fungi and lichens exceptionally emit a scent, but that scent arises from no blossom.

Just as the voice, even in creatures that possess one, does not resound without ceasing, but rather, according to the nature and habit of the creature and other circumstances, sounds now more by day, now more by evening, now more by night, now louder, now softer, and most of all around the time of the reproductive process — precisely all of this corresponds to the fragrance of plants; and this proves most convincingly that the fragrances of flowers are not merely distilled in a simple mechanical fashion by the warmth of the sun from the flower's juices, as though the flowers were small retorts for essential oils; but rather that the flowers truly develop such fragrances in accordance with the outward and inward demands of their life.

Were warmth the cause of the escape of fragrance, then all flowers ought to be most fragrant during the heat of the day and exhausted by evening. Now it is true that the labiate flowers and the rock-roses, the myrtle and orange thickets, fill the air of southern Europe with their fragrance the more powerfully the hotter it becomes; but there are other flowers that scarcely smell at all during the day and only begin to emit their fragrance at sunset, as the nightingale sings its songs only in the evening, and there is hardly a single flower that releases its scent by day alone. Indeed, in general, intense solar heat appears rather to diminish the inclination toward fragrance, as animals become drowsy in the heat (Decand. II. p. 764); which does not, however, prevent one from

believing that warmth may yet act as a helpful preparatory influence upon the development of fragrance toward evening.

In particular, all flowers of sombre colouring — such as Pelargonium triste W. Aiton, Hesperis tristis L., Gladiolus tristis L., and others — are almost wholly without scent throughout the entire day and breathe forth an ambrosial fragrance at sunset. In other plants the scent is faint by day and grows stronger toward evening, as with Datura suaveolens Willd. (Datura arborea Miller), Oenothera suaveolens Desf., Genista juncea L., and others. The flowers of Cereus grandiflorus Miller (Cactus grandiflorus L.) begin to open at seven o'clock in the evening and at the same time begin to diffuse their fragrance. Senebier claims to have cultivated narcissus flowers in complete darkness, which smelled as strongly as others (?); while in the case of Cacalia septentrionalis it has been observed that the sun's rays draw from the flower an aromatic scent that vanishes when they are intercepted, and reappears when the shading body is removed. In the orange blossom, the fragrance continues uninterruptedly throughout the flowering season with slight variations. Coronilla glauca emits its scent only by day, and even in Cestrum diurnum the fragrance is considerably weaker by night. In many flowers the scent changes after fertilisation. (Decand., Physiol. II. pp. 763, 768, and Wiegm. Arch. 1840. n. 90.)

The circumstance that among plants the principal means of intercourse is referred to a lower sense, as it is among animals, may be connected equally to the fact that the plant as a whole stands upon a lower sensory level than the animal, and to the fact that the whole of its sensory nature nevertheless

issues into a higher level than that of the animal; both considerations together conspire to assign fragrance this modified station. Let us observe that even within the animal kingdom itself transpositions of functions are exceedingly frequent. The bird's hand lies partly within its beak; in several animals the respiratory organ serves also as a limb, and so forth. Moreover, as has already been noted, scent already fulfils in part the same function among animals as among plants, only to a more subordinate degree.

One may attribute to fragrance, as to colour, the further function of attracting butterflies and other insects to the flowers (cf. p. 219); yet in this nothing is to be found that contradicts what has been said above.

XVII. Résumé

XVII. Resume.

The primitive world-view of peoples, together with the characteristic and aesthetic impression that plants make upon us directly, speaks far more in favour of the soul of plants than does the popular view prevailing among us — one resting upon inherited assumptions — which speaks against it (Ch. V.).

Plants are, it is true, on the whole less like us than are animals; yet they still agree with us and with animals in the principal fundamental features of life so closely that, even though we may infer a great difference in the manner of their besoulment from our own, we are not justified in inferring the fundamental distinction between besoulment and non-besoulment itself (Ch. II.). In general, there obtains between the two kingdoms such a relation of mutual supplementation that the soul-life of plants fills the gaps which that of men and animals would otherwise leave (cf. the preceding chapter).

That plants possess neither nerves nor similar sense-organs for sensation, as animals do, proves nothing against their capacity for sensation, since they also accomplish, without nerves and without similarly constituted organs, yet in another form, many things for which the animal requires nerves and specially formed organs; and above all, the inference that the particular form of animal nerves and sense-or-

gans is a necessary condition of sensation rests upon untenable grounds (Ch. III., XIV.).

The entire teleological consideration of nature takes on a far more satisfying character when one attributes soul to plants than when one denies it to them, inasmuch as a great multitude of relations and arrangements in nature thereby acquire a living and substantial significance, whereas otherwise they lie dead and idle or appear as mere empty play (Ch. IV., XI.).

That the plant kingdom serves the purposes of the kingdoms of man and animal cannot, however, speak against the presence therein of self-directed ends, since in nature the service of others and the pursuit of one's own ends are in no way shown to be incompatible; and the animal kingdom likewise has to serve the purposes of the plant kingdom as much as the reverse (Ch. X., XL.).

If plants as ensouled beings seem ill-placed, in that they must suffer much ill-usage from men and animals without being able to defend themselves against it, yet this appears so ill only when we place ourselves upon our human standpoint; it appears altogether otherwise when we apprehend the life of plants according to its own inner coherence. Moreover, we attach to this objection in general more weight than it deserves (Ch. VI.).

When it is asserted that plants have no soul because they have neither freedom nor voluntary movement, one either does not attend properly to the facts, which do allow us to recognise such freedom in the plant in a sense analogous to that in the animal, or one demands of the plant something

which is not to be found in animals either; for of genuine freedom, properly speaking, there can scarcely be any question even in the case of animals (Ch. VII.).

Insofar as the plant kingdom and the animal kingdom are contiguous through an intermediate kingdom where the distinctions between the two become ambiguous, yet this intermediate kingdom contains both the most imperfect plants and the most imperfect animals, one cannot simply subordinate the plant kingdom to the animal kingdom as one standing on a lower level; for the plant kingdom begins, on the contrary, to raise itself again above the intermediate kingdom through its higher forms. This, together with the circumstance that the plant kingdom and the animal kingdom share the same date of origin in the history of creation, argues that the one will not be simply subordinate to the other with respect to besoulment either (Ch. XII.).

If one misses in the plant organism the signs of centralisation, of unifying coherence, or of self-contained closure, as a condition or expression of the unity and individuality of the soul, one is again not looking to the right points, or is demanding of plants things which are not to be found in animals either (Ch. XIII.).

It is probable that the soul-life of plants is still far more purely sensory than that of animals, which, even if they lack reason and self-consciousness, nevertheless possess memory of the past and anticipation of the future; whereas the life of the plant in all probability flows on in complete absorption in the present, without thereby being absorbed into the universal soul. Yet so far from the sensory life of plants being less

developed than that of animals, it may be even more developed (Ch. XIV.).

XVIII. A Few More Occasional Thoughts

XVIII. Noch einige gelegentliche Gedanken.

Having concluded my work, I wish to sit down before the door and converse awhile, moving from one thing to another as occasion invites.

I remember full well what impression it made upon me when, after several years of affliction with my eyes, I stepped for the first time once more from the dark room, without the bandage before my eyes, into a flowering garden. The sight seemed to me beautiful beyond anything human; each flower shone towards me with a peculiar luminosity, as though casting into the outer light something of its own inward radiance. The whole garden seemed to me transfigured, as if not I, but nature herself, had been born anew; and I thought: it requires only this, to open one's eyes afresh, in order to make the old and familiar nature young again. Indeed, one can scarcely believe how new and living nature presents itself to one who approaches her with a new eye.

The image of the garden accompanied me back into the dim chamber; yet in that twilight it became only brighter and more beautiful, and I believed all at once that I perceived an inward light as the source of the outward clarity upon the blossoms, and that I saw colours working spiritually within them, colours which merely shone through into the exterior. In that moment I did not doubt that I beheld the soul-radi-

ance native to the flowers themselves, and thought, in a strangely rapturous mood: thus does it appear in that garden which lies behind the boards of this world, and all the earth, and all the body of the earth, is but the enclosing fence around that garden for those who still stand without.

Consider for a moment: suppose you had spent a half-year's night at the North Pole, and in that long interval had nearly forgotten what a tree or a flower looks like, having seen nothing but desolate fields of snow and ice, and were then suddenly transplanted into a garden glowing in mild light and in full bloom, and stood, as I once stood, first before a row of tall dahlias — would you not also find them wondrously luminous, and feel a presentiment that behind this adornment, this splendour, this joy, there was something more than common fibre and water?

That bright image faded, as so much else faded that in those first days touched my outer and inner eye with a kind of trembling awe, which no longer falls upon the senses dulled by the daily enjoyment of light; the plants became, as my eye grew accustomed, once more the ordinary, earthly, unremarkable, ephemeral creatures they appear to everyone — until in the dreaming gaze cast upon the water-lily, the soul of the flower presented itself to me again, living and present, and reminded me more urgently of the task which I have now fulfilled. Certainly an echo from that first time was mingled with it; and so, I believe, this book would scarcely have been written had not my eyes been laid in darkness and then so suddenly given back to the light.

Many an hour have I since spent in endeavouring to render clear to the understanding, and accessible to other minds, that which fell upon my spirit in a few luminous glimpses; and many a meditation has it cost me, and not without effort, to discover whether I might succeed. How much there was to take apart and put together again. And when I had first grasped the spirits of the flowers, they now began to take hold of me, and would not release me again, and compelled me — often as I wished to turn elsewhere — to remain in their service; and when today I had spun off the tow they had hung upon my distaff, I found new tow upon it again by morning. So has the thread grown so long.

Now, however, I rejoice to have wound the end upon the spindle, and affix only, as a final gesture, a few ribbons to flutter in the open air, in dark and light colours as the day has offered them — signs of the earnestness and cheerfulness that have attended the whole work.

Today I came upon a funeral: a preacher stood at the graveside upon the mound of freshly turned earth, and spoke upon the text (1 Cor. 15:36-37): "That which thou sowest is not quickened, except it die. And that which thou sowest, thou sowest not that body that shall be, but bare grain, it may chance of wheat, or of some other grain." Two long palm branches, removed from the coffin, leaned within against the railing that enclosed the burial plot, and waved their green pennants high above the black iron bars; many a wreath of flowers, which had also earlier adorned the coffin, hung upon the railings round about. The preacher praised aloud the virtues of the deceased; meanwhile a bee circled among the

wreaths, humming softly yet as if in discontent, seeking in all the blossoms and finding in none what it sought; for the fountains of fragrance and sweetness had run dry. A butterfly, however, soared up without concern for the withering sources of its former pleasures, over the churchyard wall and into the open beyond. On one wreath I saw drops hanging to keep it fresh, and in a few eyes tears that would perhaps dry there and elsewhere before long; then the flowers and the memories would wither alike. A weeping willow cast its shadow over the neighbouring grave, but its roots reached searching into the fresh one; it was to seem newly called to mourn, and not without reason. A white tablet, wound about with green ivy, declared the lineage of those who had gathered here to their fathers. Thus did the world of plants attend the burial of a human being.

It occurred to me, as I contemplated all this, how much unconscious symbolism here plays into the conscious symbolism of man; and further, how singular it is that while the human being takes so little to heart the dying of plants, they for their part participate so deeply in his dying. The fruit of the citron and the herb of rosemary go to the grave; many a green wreath follows a young girl down into the grave itself; every time a tree must die, so that with its body it may enclose the body of the human being and decay along with it. Now the plant knows nothing of the fact that in what it here joins and suffers, the death of a human soul is at stake — just as the human being knows nothing, or wishes to know nothing, of the fact that with the plants, plant-souls too come into play in these matters. Indeed, does not the life and dying of

the human and plant worlds everywhere interpenetrate, and yet do the souls of both kingdoms neither know nor greet each other — like people who inhabit one and the same great city, pressing and pushing through one another's midst, yet without running into or greeting each other? Is that not a sad and fragmented state of affairs in the realm of souls? Sad indeed, if it is as we mostly conceive it to be. But I think there will be a higher knowledge which thinks the fate of human and plant and all souls in relation to one another — nay, which itself places them in relation. For this knowledge, it will matter less how the palm branches, the wreaths, the flowers, the trees, the bees, the butterflies present themselves outwardly beside the coffin and the grave, than how the souls of the palm from which the branches were taken, of the flowers that go to the grave, of the trees that stand around it, of the flowers that will grow up once more above the grave, and of the bees and butterflies that fly around and above those flowers, present themselves to the human soul in its homeward journey. And as this knowing being finds the spectacle most meet, so will it be ordered by it, in a beholding face to face. We, however, see all things only in part, as through a mirror, in a dark word; and when a symbolic gleam of light from it falls into our souls, we presume straightway that it has fallen out from our souls themselves.

Not everywhere, to be sure, do flowers and plants play the same part in human death as they do among us. Wild peoples slaughter horses, sheep, and dogs at the grave, or sacrifice them into it, rather than flowers and plants. But there, perhaps, lies the very point. It is altogether befitting that a great

mistress should not travel into a foreign land without an attendant retinue of subordinates. Thus too the mistress of the earth, the human soul, should not travel to the kingdom of heaven without an escort of other lesser souls. Here she takes animal souls with her; there, plant souls. But why, among us, plant souls in particular? Is it perhaps because in Christianity there is indeed mention of a garden of paradise in the beyond, yet no mention of animals therein? So then each human soul must bring its own contribution of flower-souls towards it. Animals are not required. Only the butterfly must accompany it symbolically in flight, lest the flower-souls find it all too lonely in the garden above; and heaven ought, after all, to be a heaven for them as well.

Even among the Greeks, things proceeded somewhat differently than with us. Since body and bodily life still possessed a flourishing significance for them, they laid the body of man itself upon the wood like a flower, and tree and body ascended together in fiery flames toward heaven, to the dwelling-place of the gods. With us, where the very conception of body and life has become lignified, the body is enclosed like a dead grub within dead wood as fodder for other worms, and flowers are laid only outwardly upon the coffin and the grave. Thus, from life unto death, things were so much more beautiful among the Greeks than with us. Yet only so much more beautiful in the sensuous sense, while perhaps much that is thoughtfully beautiful comes to pass with us instead.

Into this reflection steals the memory of the lovely festival of the dead observed annually in Leipzig at Johannistide.

Then all those who have someone sleeping in the churchyard, whom they still hold in loving remembrance, go forth to wreathe the grave; and those who have no grave to garland go to behold the wreaths and the wreath-bringers. The otherwise solitary burial ground becomes colourful and animated; people press among one another, coming and going, a living company gathered above the quiet one. Only toward evening does stillness and emptiness return above; only the wreaths remain, mindful of their appointed destiny: to wither.

What beautiful garlands and wreaths one may behold there. As the living at a ball strive to surpass one another in adornment, so now the graves make the same attempt. Yet the most beautiful flowers and wreaths are soon forgotten; who can retain each individual one in memory? Only a simple little sprig of clover I cannot forget, which, after so many richly adorned graves, we encountered lying alone upon a green mound. Surely the soul that lay there was different from the others — she who, amid all the rich ornament around her, gave the modest little blossom its solitary place.

I should not care to end with thoughts of the grave, and so I gladly recall how plants take so great a share not only in the sorrowful but also in the joyful occasions of human life, and how much of his own delight man owes to them. Might one not say that the whole plant kingdom winds itself like a beautiful arabesque around and between the realm of humanity? Man himself, with all the splendour of his garments and all his artfully fashioned implements, rises half-bodied from below out of the world of plants; and from above, flowers and grape-clusters grow toward the reaching hand, toward the

longing mouth. And over all of this hovers the most beautiful fragrance of poetic relations.

Where is there a festival that flowers have not adorned, where a poem to which they have not lent their images, where a gift whose worth they could not enhance with their ornament? The myrtle brings the wreath to crown the bride; flowers come from every garden to lay themselves at her feet; doorways twine themselves with colourful floral garlands to let her pass; the wedding herald prides himself on the bouquet in his hands; flowers again await upon the table; and in the evening at the dance, how many a blossom still adorns the breast and hair. The laurel presides over the highest honours; forget-me-not calls remembrance itself to mind; the snowdrop lures the children for the first time into the green wood; the first aster announces that autumn is come; the linden spreads a green roof over the table before the house; the oak hails the German even in a foreign land as a countryman. The fir casts away its pine cones and enters the hall adorned with golden apples and candles and ever so many beautiful gifts. So may it now bring to this holy Christ-tide the loveliest things for the loveliest, the best for the best, and the most for the poorest.

Yet let every plant in its lowliness remain mindful that it is a creature of God and before God, which possesses its freedom only in bondage and ought to exercise that freedom only in fellowship.